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PRACTICAL

GAS FITTING.

TWO ILLUSTRATED ARTICLES REPRINTED FROM "THE METAL WORKER," DESCRIBING HOW TO RUN MAINS, LAY PIPES AND PUT UP GAS FIXTURES.

NEW YORK:
DAVID WILLIAMS, 232-238 WILLIAM STREET.
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PREFACE.

A DEMAND exists for a short and concise practical account of the best methods of doing gas fitting.

The two articles which we reprint were prepared by practical gas fitters and will together constitute a complete practical treatise on this work. The reader will observe that the two articles are quite different in their treatment of the subject. We think that they are particularly valuable on this account, as they cover it from two points of view, and the descriptions, although prepared independently, necessarily supplement each other in a number of particulars.

The many illustrations help out the text and show how many things are done which are difficult to describe in words alone. We believe that the plumbing trade, especially the younger members of it, will be helped by a book of this kind, and we hope that it will meet the needs of many who are looking for plain and simple instructions in this important department of the plumber's work.

PRACTICAL GAS FITTING.

First Article.

BY J. W. HUGHES.

Practical Gas Fitting—I.

Introductory.

It is my intention to write a series of articles on gas fitting suitable to the requirements and understanding of the ordinary reader. It is my special desire to make the articles of use to those who may be called upon, from time to time, to execute in a practical way such work as may come to hand in the usual course of a small plumbing and gas fitting business conducted in a large city, or in the general tinsmithing plumbing and gas fitting shop of the smaller towns. Little that is new will be advanced, and anything in the way of the higher science of the subject will be avoided. The first, because anything new on the subject of ordinary illuminating gas, speaking in a general way, is exceedingly hard to find; and secondly, because the higher scientific side of the question would, I take it, be of little practical interest to my readers. My authorities will be the encyclopedias, mechanical dictionaries and facts gleaned from writers of authority, supplemented by information gathered from practical gas fitters, whose life work has been the fitting up of the various pipes and fixtures. Finally, such knowledge on the subject as some 30 years' general practice in the art has given me is at the disposal of the reader provided I have the skill to put it within his reach.

When the ordinary person hears gas spoken of the conclusion is immediately come to that lighting gas is the subject under discussion. But the word "gas"

covers a larger field. An old dictionary explains the word as follows: "Gas—a spirit not capable of being coagulated; the essential spirit into which all matter is resolvable; an inflammable vapor, which is obtainable from combustibles, and is used for lighting up; also obtainable by decomposition from all things, more or less." Rather a quaint definition, but in the main correct enough to suit the present purpose. The "obtainable from combustibles" and "is used for lighting up" (part of the above quotation) is what is of particular interest in the present case. Such a person will also have in his mind the idea that gas is quite a modern discovery or invention. He is aware that the grandfathers of the present generation of mature years used whale oil and tallow candles when they did any lighting up. But there is nothing new under the sun, and natural gas has been used from remote times in China, Central Asia and near the Caspian Sea for purposes of heating, lighting and manufacture. It is undoubtedly true, furthermore, that the sacred and perpetual fires that received the adoration and worship of that very ancient religious sect, the Fire Worshipers, were gas fires fed by natural gas issuing from fissures in the earth.

The general introduction of gas as a lighting material is undoubtedly of modern origin. About 1786 Earl Dundonald made experiments on gas lighting at Culross Abbey, his search, however, not being for light but for the tar that resulted from the distillation of coal. The gas in the noble Earl's works was a by-product, being regarded as a very interesting curiosity. In modern gas works it is the gas that is sought for (the tar being one of the by-products), although the by-products of an up to date gas plant, consisting of coke, tar, ammonia,

aniline dyes, etc., are more valuable than the gas. In fact, I have authority for saying that though not a foot of gas was used for ordinary lighting and heating purposes, the distillation of coal would still be a very profitable industry.

In 1792 William Murdock lighted his shop at Redruth, Cornwall, with coal gas. He afterward fitted up a more extensive plant near Birmingham, England, for lighting the workshops of the celebrated firm of Boulton & Watt, engine builders, and about 1803 he fitted up several cotton mills in Manchester. To him is generally given the credit of being the discoverer and introducer in a practical way of modern gas lighting, and not without right. However, as far back as 1667 the "Transactions" of the Royal Society gave an account of a burning spring in one of the coal districts of England, and alluded to the fact that Thomas Shirley traced its source to gas escaping from the underlying coal beds. It is not necessary to go further into the history of gas, but it is to be hoped that enough has been put before the reader to awaken an interest in the subject and prompt the reading necessary to fuller information.

Coal gas, which is most commonly and generally used through the world for lighting, heating and cooking, is obtained by a simple process of distillation, bituminous coals being selected as most likely to give the best results, although cannel coal holds a high place in the opinion of gas engineers.

The Distillation or Manufacture of Coal Gas.

The principal processes employed in the manufacture of ordinary lighting gas, distilled from coal, are the heating of the coal in retorts for the purpose of driving

out the gas, leaving in the retort what is known as coke; next the purification of the gas by passing it over and through certain substances, the principal of which is milk of lime. By these methods, known as washing, scrubbing and condensing, are removed from the gas certain substances that would seriously affect its usefulness as a lighting mediufn, and at the same time these substances are recovered and put to proper use. After the gas has been purified it is passed into large storage tanks called gas holders, from which it is drawn, or rather forced, into the various pipes, called mains, by means of which it reaches the consumer at the most distant point. It will not be necessary for the purpose of this article to go minutely into the details of the manufacture or distillation of coal gas. Any reader who desires to thoroughly understand it can obtain all necessary information from the standard encyclopedias or from any of the numerous special publications treating on the subject.

But an old and simple experiment may be tried that fully illustrates what takes place in the retorts of the gas works. Take an ordinary clay tobacco pipe, fill the bowl with fine particles of gas coal. Then seal or cover the coal with fire clay. Next insert the bowl of the pipe into the fire, and in a few minutes apply a lighted match to the stem of the pipe, when the gas, being distilled from the coal in the bowl of the pipe, will ignite. This is, of course, gas in its crude, unpurified state, but in just about the same condition as coal gas was when originally used for lighting purposes.

The washings and other treatment that the gas undergoes in a modern gas works are the result of practical experience, assisted by the art of the chemist, the object of the gas engineer being to obtain an illuminat-

ing medium free from smoke and smell and the chemist to find out what the substances were that gave trouble to the engineer, and afterward to put these materials to commercial use. Having made the gas and purified it, the next question is to store it for use, as gas is not required in the same quantity in the daytime as at night, and it would not be possible to keep banks (sets) of retorts working sufficiently to supply the demands of the consumers at night. This is accomplished by passing the gas into the gas holder, sometimes called gasometer. These gas holders are immense inverted cups made of sheet iron and working up and down in slides, the lower ends of the holder being immersed in water. The pipes leading from the gas house where the process of manufacture is being carried on convey the gas into the holder above the water, and as the gas enters it causes the gas holder to rise until it is full, or raised up to its limit. The main distributing pipe or pipes, which are taken from the holder, also project above the water, which forms the seal and keeps the gas from escaping, the pressure being regulated by a system of weights and pulleys.

Formerly when the holders were made of very heavy iron plates it was necessary to relieve the pressure by balance weights, but the modern holders being comparatively light, it is somtimes necessary to weight the holders in order to give the desired pressure. It is very essential, in order to have perfect consumption and light at the gas burner, that the pressure should be constant and of the right force. This can be attained, to a certain extent, by adjustment of the holder at the works, but as coal gas is lighter than the air it increases in pressure according to hight at the rate of about one-tenth for every 10 feet. That is, if gas is

delivered into a building at the lower story at, say, four-tenths pressure, it will be five-tenths pressure 10 feet above the lower story and go on increasing according to hight.

The same disturbance of pressure takes place if gas has to be distributed on levels above the gas works. For this reason some form of pressure regulator is neces-

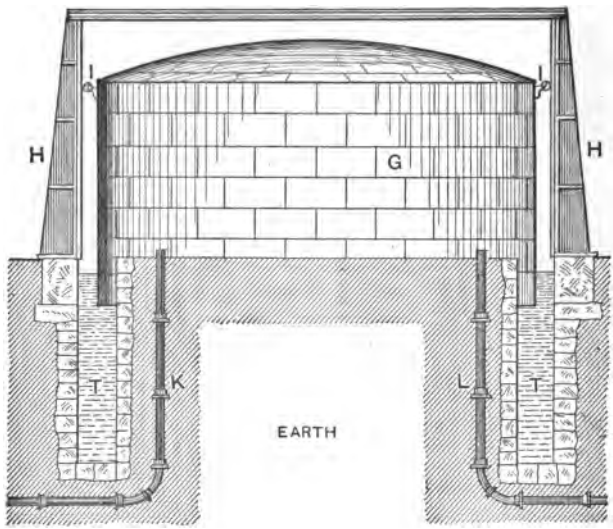

Fig. 1.—Section through Gas Holder.

sary in high buildings, or in buildings situated on high ground. Of these governors and the necessity for them we will treat at greater length in a future article. The accompanying sketch, Fig. 1, shows a section of a gas holder. G, gas holder; H H, guides or steadying frame, on which work rollers I I, which are attached to G. T T, tank or pit filled with water into which G de-

scends when empyting or empty; K, pipe entering holder above water line for letting gas in—that is, charging or filling pipe, while L is the discharge or main distributing pipe. The pit is generally made of brick and cement, and in cold climates the whole arrangement has to be housed in to prevent freezing of the water.

The Distribution of Gas From the Gas Holder Through the Town.

Having our completed gas works with holders full of gas, the next question is to get it to the consumer. For this purpose it is necessary to lay the mains or pipes under the streets. As these articles are specially intended for the gas fitter, as best known to the general public—viz., the man who introduces the pipes into the houses and puts up the gasaliers and brackets—it will not be necessary to go into the general details of the various processes used in the laying of large street main pipes, but simply give a general idea of them so as not to break the continuity of the subject.

The first care of workmen employed in the fitting of gas pipes, or any work that may bring them into immediate contact with gas, must be for their own bodily welfare (health). Gas of any kind if breathed into the lungs is a deadly poison, some kinds of gas being more deadly in their effects than others, but the danger is ever present and differs only in degree. A workman who is compelled to work for any time where it is impossible to avoid inhaling gas should take such precautions as may be within his power to reduce the danger of suffocation to a minimum. Every joint and fitting should be tested before attempting to put them together in an excavation, or any other place where a final con-

nection may have to be made with gas turned on, as it generally is. A short time ago in the city where the writer lives an old employee of the gas company lost his life for want of such precaution. A bolt he had to screw up was too short or had some defect in the screw thread that compelled him to work longer than would otherwise have been necessary over a large escape of gas, resulting in his being overcome to such an extent that he died. There should always be an intelligent helper at hand in case of accident to afford immediate assistance, and the workman, the moment he begins to feel the least giddy, or confused, should go away from where the air is impregnated with gas, preferably out into the open air, and fill and empty his lungs by inhaling all the fresh air he can and rapidly breathing it out again, repeating the operation for a number of times. And it is not safe after once being overcome, or partially so, to at once expose oneself to the gas fumes, but a considerable interval of time (several hours) should elapse before so doing. When any one is overcome by gas the usual means taken for his recovery are the same as for one smothered from any other cause, the details of which will be given later.

The mains leaving the gasometer are usually made of cast iron, of such size as the magnitude of the work may call for, and are laid in trenches, suitable valves being fitted in the vicinity of the gasometer for stopping off and controlling the gas. Gas regulator valves for the proper adjustment and maintenance of the pressure are also frequently used. It is customary in well managed gas works to first carry the gas to what is known as the station meter, which serves to measure the same and keep a record of the consumption. In laying mains care must be taken to so grade them to

certain points that any moisture that may accumulate in the pipes will run to a place provided for the collection of the same, called a siphon. This is so fitted that a pipe from it comes to the surface of the ground, to which, from time to time as may be necessary, a pump is attached and the accumulated liquid (gas water) pumped out. This is carefully saved and from it are derived certain substances of commercial value.

There are various kinds of joints used in putting gas mains together, the ordinary calked lead joint, Fig. 2,

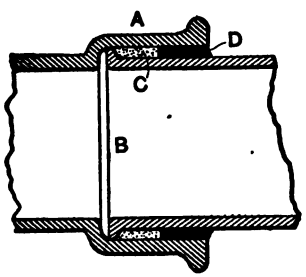

Fig. 2.—Section through Calked Lead Joint.

Fig. 3.—Lead Calking Tool.

made by driving oakum into the hub or large end of the pipe and afterward running in molten lead which is set or wedged tight with the calking tool, Fig. 3, being one common kind of joint. Another is made by a similar arrangement of the ends of the pipe, but the space is filled with oakum, soaked in a mixture of red lead and oil, and a third, Fig. 4, is made by having the ends of the pipe so arranged that they make a close fit, and the spigot end of the pipe, being well painted with red lead, is simply driven into the hub, that is made to correspond with a fair amount of exactness. Where

wrought iron pipes are used the ordinary screw thread is employed, which is put together with red lead and screwed up with tongs.

Referring again to Fig. 2, A is the large end of the pipe, called the hub or socket; B, the small end, called the spigot; C, oakum driven in with the calking tool; D,

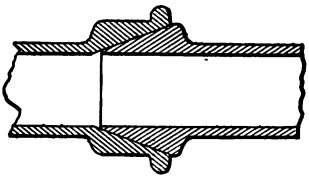

Fig. 4.—Stopper Joint.

Fig. 5.—Oakum Calking Tool.

lead poured in hot and afterward calked or driven tightly home with a calking tool. The calking tool for driving in the oakum is shown in Fig. 5. The different calking tools vary in shape, size and length according to the work to be done.

The quantity of lead to be used in making a joint of

course varies with the size of the pipes. A rule is 1 pound of lead for each inch of diameter of pipe, or 4-inch joint 4 pounds of lead, and so on; but common sense and brains have to be exercised in this as in all other matters. It is safe to say that the pipe layer must leave enough space for lead above the oakum to insure a solid body of lead being in the hub. A thin skin on top of the oakum is not a lead joint, but only the skeleton of one. No special skill is required in making leaded joints when the joint to be made is upright so that the lead can easily be poured into the hub, care being taken to drive the oakum home hard to prevent the lead running into the pipe. It is next in order to pour in the lead. It should be hot enough to run freely, but not red hot, and a sufficiently large pot or pouring ladle should be used to enable the joint to be made with one pouring—that is, a good joint is not made if the space to be filled by the lead is only partially filled on the first pouring, and the operation has to be completed by a second.

When the lead has cooled it is calked by means of the calking tool and hammer, care being taken not to split the hub, which can easily be done if too large a hammer is used or too violent a blow is struck. What are called "slugging" blows must not be used, but a succession of solid taps sufficient to fully expand the lead and make the joint tight and no more is what is required. Making hub and spigot joints with red lead and oakum is a similar process to the one just described, except that the joint is made tight without the use of lead. The method of putting together pipes with the fitted joint will be understood by an examination of Fig. 4. It is sometimes called the stopper joint, it being similar to the stopper in a glass bottle.

When leaded joints have to be made in a horizontal position a special mode of procedure is required, differing somewhat from that employed in making an upright joint, the special features having reference to the method employed in introducing the molten lead. To do this it is necessary to use what is called a "clay gasket," although there are now in the market special gaskets made for the purpose. To prepare the clay gasket, take a sufficient quantity of ordinary clay, well puddled (mixed). Have prepared a piece of flat board of sufficient length for the purpose—viz., long enough to make a gasket on that will completely encircle the

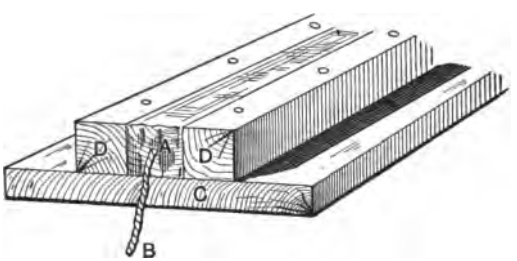

Fig. 6.—Preparing Clay Gasket.

pipe. To this nail two strips of wood of a size to suit the gasket to be made, which varies according to the size of the joint, but is usually about 1¼ inches square. The distance these strips are placed apart corresponds to the size of the desired gasket. The space formed by the two strips and the board to which they are nailed forms two sides and the bottom of a trough, or gutter. Work in the clay, putting into the center of it a piece of strong string several inches longer than the clay, to keep it together, as in Fig. 6. The wood must be kept well moistened and the clay be of such a consistency that it will hold together, about the same consistency as

ordinary glaziers' putty, which material, by the way, is frequently used for the purpose when small joints are to be made.

Having worked the clay well down into the groove and smoothed it off on the top, take hold of the two ends of the string projecting from the clay and lift the gasket out of the gutter. Pass one end of it under the

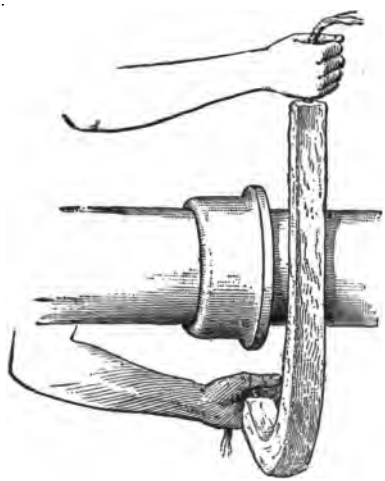

Fig. 7.—Putting Gasket Around Pipe.

pipe, as in Fig. 7, bringing it around on the opposite side to the top of the pipe, Fig. 8, where cross the two ends of the gasket so that a small cup or " pour hole " will be on top of the pipe. Keep one angle of the gasket against the opening of the joint, being careful not to work the clay into the joint, and see that it firmly adheres to the pipe. This is best done by rubbing it with the hand well moistened just before the lead is ready to pour, the object being to have the clay sufficiently firm to resist the weight of the lead while in the molten state.

Next pour in the lead by the pour hole, and as soon as it has set remove the gasket, trim off the projecting piece that has been left at the joining point, trim off with a sharp chisel any inequalities caused by the non-fitting of the gasket and calk tight, as before described. A little practice is, of course, required to get into what is called the hang of it, but the operation is a simple one. Again a word of caution. Great care must be taken before forming a lead joint that there is no water or moisture in the joint. If there is, the lead will be violently blown out and the workman is likely to have to lay up for repairs, and if he escapes with his eyesight uninjured he will be fortunate. Where joints have stood in the rain any time with only the oakum in them, it is safest, and therefore best, to remove the oakum and calk in fresh. But the better plan is not to let joints stand, but finish them at once if possible. Where a joint is doubtful on the moisture point, a little tallow put into it has a quieting effect. Always pour from the back of the joint—that is, away from the opening—and keep the head away from the line the lead will take if violently blown out.

Referring to Fig. 6, A is the clay forced into space formed by bottom board C and strips D D nailed on to it; B is the string projecting from the clay.

Fig. 7 is a sketch of the gasket held in the hand by the string just previous to passing it around the pipe, showing one hand holding the gasket up, while the other, passed under the pipe, has caught the string of the lower end in order to draw the gasket around the pipe.

Fig. 8 shows the position of the gasket after it has been passed under the pipe and just before turning down on top of the pipe to form the pour hole. In

doing this the workman sits astride of the pipe, back of, and facing toward, the rear part of the hub.

The pour hole is formed by keeping the two ends of the gasket away from the face of the hub for 1 or

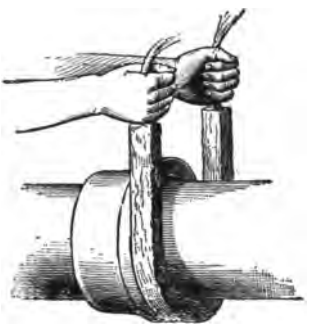

Fig. 8.—Gasket Placed Around Pipe.

2 inches on the top, then laying them down on the pipe and working a suitable sized and shaped aperture into which the lead can conveniently be poured. One angle of the gasket fits against the aperture in the joint

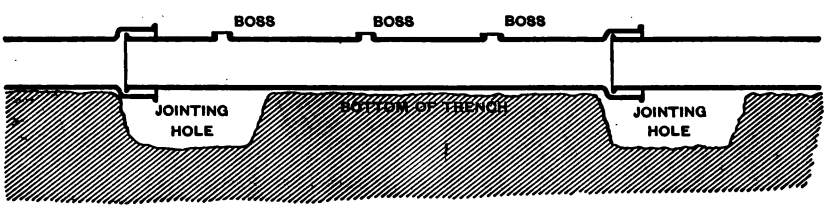

Fig. 9.—Section through Bottom of Trench.

which is to receive the lead, and, if nicely adjusted, when the gasket is taken off the joint will be found filled flush and even, and no trimming will be required except the removal of the piece that has filled the pouring hole.

In trenching there has to be made at proper intervals a depression or recessed part in the bottom of the trench, as in Fig. 9, and sometimes at the sides when large pipes are being laid, to afford space in which to perform the various operations of joint making.

The mains are laid sufficiently below the surface to insure their freedom from injury by the weight of pass-

Fig. 11.—Service Pipe Connection With Saddle Piece.

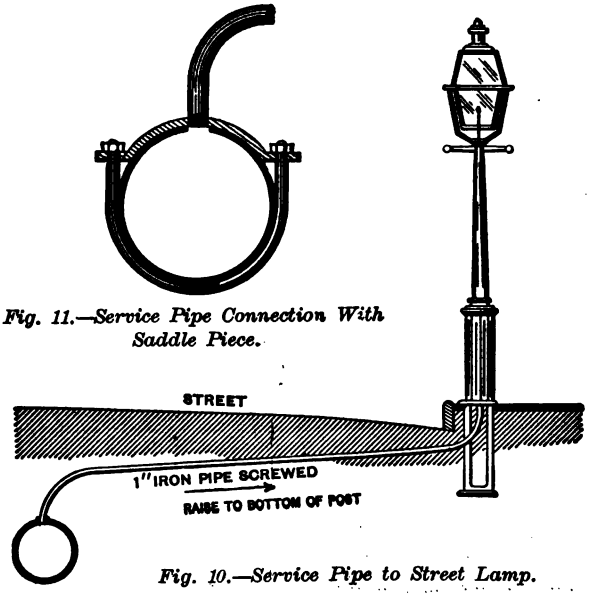

Fig. 10.—Service Pipe to Street Lamp.

ing vehicles, and must be protected against shifting or disturbance, as a broken joint and a large escape of gas is a serious matter, frequently involving the loss of life and property. At the proper intervals to the mains are attached the service pipes that are to serve as means for conveying the gas to the different buildings and

lamps. These are usually of wrought iron pipe with screw joints, and are connected with the mains in several ways. It is better they should be taken from the top of the main and have a decided rise from the main to the building or lamp they are to supply, as in Fig. 10. The usual method of connecting them to the mains is by means of a screw thread, a suitable hole being drilled and tapped into the main for the purpose. A boss is generally formed on the mains for this purpose. Sometimes it is more convenient, especially in old work, to connect them by means of a saddle piece and bolts, as in Fig. 11, the joint between the saddle piece and main being made tight with red lead putty.

Connecting the Meter in Buildings.

In most cities the gas is introduced directly into the buildings to be lighted by the gas company. For an ordinary dwelling the usual size of a service pipe, as the pipe leading from the street main to inside the building is called, is 1 inch. It is generally wrought iron pipe with screw joints, put together with the ordinary socket or buckle, and made tight with red lead. Sometimes a stop cock is fitted in the service outside the building for the purpose of cutting off the supply, but in many towns this is omitted, the pipe inside the house being merely closed with a cap.

When the gas fitter comes to make the final connection between the gas company's service and the house pipes, he removes this cap, having first prepared a proper fitting with a nipple and cock to screw on the end of the main or service. The proper fitting to use is a T with a plug in one end. In cold climates it is customary to fit to the end of this T a cock to which a

small funnel is attached. This is for the purpose of introducing alcohol to thaw out the main should the flow of gas become diminished by the accumulation of frost in the service. Gas does not freeze in the same way that water does—that is, into solid ice—but during severe and long continued cold spells frost gathers on the inside of the service, similar to that which gathers on the inside of the window glass, and for the same reason. The moisture carried by the gas is condensed on the sides of the pipe in such quantities as to sometimes completely obstruct the flow of gas.

" High wines " or alcohol introduced into the pipe cuts this away, and if the service has been laid with ample fall from the house to the street main, it runs off into the large main and from there to the various siphons placed at intervals along the line of the street mains, from which it is periodically pumped by the gas company men, along with the ordinary liquid of condensation that forms in the mains and which is known to the general public as gas water. Should there, however, be a depression or trap on the service the alcohol will lodge there, and as a result there will either be no flow of gas or it will come in jerks or jumps, causing the flame at the burner to jump up and down.

This jumping is also caused by the ordinary liquids formed by the condensation in the gas. The proper and only thoroughly effective remedy for this is to dig up the service and lay it so as to be free from traps or depressions. The trouble may be temporarily cured by removing the plug or funnel on the end of the service, and having fully inflated the lungs, placing the mouth over the opening made by the removal of the plug and blowing strongly into the service until the accumulation of liquid is blown out of the trap and

back into the main pipe. This is not the most pleasant job for the gas fitter, but it is a prompt and handy method of getting rid of the trouble. When no plug has been left a joint may be unscrewed or the key taken out of the stop cock, or the coupling may be taken off at the meter and the alcohol be introduced at any of these points, as most convenient, and the blowing out be done from there if necessary. It sometimes occurs that the force of the lungs is not sufficient to free the service from the accumulated liquid. Then a force pump must be used, or a wad of rag, well greased, can be attached to the end of a strong wire and this be forced into the service to a point beyond the line of obstruction. If this is not possible, a closely fitted wad of rag firmly attached to a wire will answer all the purposes of a force pump.

When working at gas pipes with gas on, as is sometimes necessary, especially in executing any of the aforementioned work, great care must be taken to prevent the gas taking fire. No light should be anywhere in the vicinity, and as the services are frequently situated in dark cellars it adds to the awkwardness of the work. For this reason everything in the way of a most perfect preparation should be made and the light removed before any pipes are opened. Fittings should be tried to make sure they will screw on to the pipe, so that a man working in the dark will not be unnecessarily embarrassed. It is always better to open a window to the outer air while such work is being done, and even after the special work has been accomplished a light must not be brought into the apartment as long as there is a strong odor of gas, as gas in the proportion of seven to eight parts of air to one of gas is highly explosive, and enough will accumulate in a few minutes in a

cellar to form an explosive compound of sufficient force to wreck the building.

Having attached the stop cock to the main inside the house, it is next in order to carry the service to the vicinity of the meter. The final attachments between the street service, the house main and the meter should be made with a short length of lead or "compo" gas pipe. The meter should not be connected direct to the iron pipes. This is something often done, but unless great care is taken to have the different parts or joints come perfectly together without spring a strain is put upon the meter it is not strong enough to stand and serious injury to the meter is almost certain to result, whereas if a short piece of "compo" is used at the meter it can be much more easily handled, and there is less likelihood of damage to the meter from the aforementioned cause. The meter couplings are usually made for "compo" connections. The end of the "compo" pipe that is to be attached to the iron pipe must be soldered into a proper brass screw tail, or brass bush, for screwing into the iron pipe fittings. The meter connections described above are shown in Fig. 12. A is the street main; B B, house service; C, the ⊤ on end of service; D, small cock attached to funnel E; F, main stop cock; G, continuation of service to meter I; H H, "compo" pipe connections to meter; J J, house main.

Inspection of Material and Work.

Having introduced the service and connected the meter, it is next in order to take up the question of the sizes and distribution of the different pipes for the conveyance of gas from the meter to the different fixtures, stoves, fire places, etc., in a building.

Before so doing a few general hints as to conduct

and procedure will be in order. The rule for the successful gas fitter to observe, first, last and all the time, is to be careful. It is much easier to find a sand hole or a defective thread in a fitting when it can be held in the hand and carefully overlooked than it is to find the same hole when the fitting is in place, and that place usually the most awkward place possible, perhaps be-

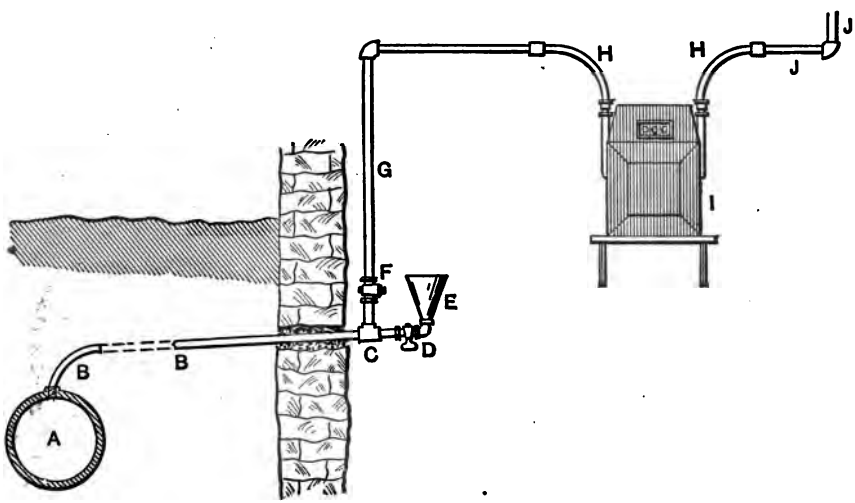

Fig. 12.—Meter Connections.

hind a beam, or covered by flooring or lath and plaster. And, having found it, the cost of its removal and replacing, or otherwise making good the defect, is at least tenfold what it would have been had a little care been taken to find the defect before the fitting in which it exists is put in position.

The same remarks apply to choked or split pipes, or pipes having a defect in the thread. Some leaks are the result of the work entailed in fitting the pipes in

position, but the greater portion of them are defects in the material that can be found at the proper time—viz., when the pipes are being handled at the bench. An excellent plan is to treat the smaller malleable fittings —that is, from ¼ to ¾ inch—as if they were all defective, by coating them with an asphalt varnish. This is quickly and inexpensively done in the shop by putting a quantity of the varnish into a large pot (a big solder pot answers very well), warming it sufficiently. Do not get it too hot or a very ugly fire will be the result. Then, having strung the fittings on a wire, dip them into the warm varnish, letting them remain until they have become as hot as the varnish. Lift them quickly out, shake violently, and hang up to harden. This method effectively disposes of the little, almost invisible sand holes so common in small fittings, even when made by the very best of makers. Before doing this the fittings should be looked over for any of the more serious defects, such as poor threads, large hole, misshapes, etc. An experience of many years in the use of gas fittings, made by the best of makers, American, Canadian and European, warrants the statement that the taking of the foregoing precaution pays in time, temper and reputation.

Never let a new job out of your hands until it is certain that it is tight. A pump for testing costs little and will save its cost on one job. Having applied it, heed the lesson it teaches and never give up until the job is tight beyond question. I write this for the benefit of fitters in small shops and such places as may be without superintending foremen or gas inspectors, and knowing from personal experience how strong the temptation is to pass over a small leak, the only evidence of which is that the pump gauge will not stand.

It is wearisome to spend hours climbing about a new building looking for something that can neither be seen, smelt nor felt, yet which you know certainly exists. But it is a much more serious matter to have to hunt for a similar leak in a finished building. Carpets to raise, floors to take up, plaster to break, fixtures to remove, and last, but not least, a justly indignant housewife who drops in every few minutes and helps the worried gas fitter keep his temper by making nice, pleasant remarks. Find the leak and make the job tight every time is the only rule. There is no short cut for any one worthy the name of a gas fitter.

Having got the job tight, every care must be taken to see the pipes are in such a position that they will not be injured by any of the work to be done after they are placed. See that due allowance is made for any settling that may take place which may break a pipe, and that floors, base boards, architraves, mantels, laths, furring, etc., may be put in position without coming in contact with the gas pipes in such a way as to injure them. I have seen a carpenter laying flooring take the back of his axe and hammer a gas pipe out of the way, this being easier and quicker than taking the edge of the axe and trimming off the floor so as to make room for the pipe. The gas leak was "none of his funeral;" he was only interested in laying the floor, and if he was doing it piece work, so much a square, as is frequently the case, he had no time to waste in nice trimming to meet the shortcomings of the gas fitter. See that the pipes are well secured, especially those pipes that have to carry heavy gasaliers or brackets.

Take care that nipples and drops are plumb and tight, and so secured that they will stay so. During all the various processes of construction that follow the

fitting of the gas pipes, a gasalier will not hang plumb, nor a bracket set parallel, unless the nipple and drop are properly set. See that drops are a proper length to suit the center piece. If the exact depth of centers cannot be ascertained have the drop so set that it can be easily removed and replaced. Make proper allowance for projection of nipples for side brackets beyond plaster, so that the bracket will screw on with the ordinary back plate and make a proper and neat connection. Be especially careful to set bracket nipples (when there are two or more on the same wall) at an equal hight to 1-32 inch. A slight variation in hight may be unnoticed by the eye in an unfinished building, but the difference be quite discernible when the walls are finished and the brackets in place, especially if walls are decorated to an exact pattern. Be certain the drops are in proper position in the center, or otherwise, as the case may be. To ascertain the exact place is sometimes difficult, and the architect, plasterer or decorator may have to be consulted. The right way to take ceiling centers is a very much disputed point, especially when there are breaks or projections to complicate the problem. But it is the gas fitter's duty to ascertain as definitely as possible what is to come in the way of interference after he has finished his work.

Laying Out Piping.

Avoid as much as possible the placing of pipes on outer walls, or in such positions as may be cold or subject to drafts from around door or window casings. Where a pipe must be placed in such a position a little time spent in wrapping the pipe with building paper, calking cracks with oakum, or taking other precautions against the cold walls or drafts coming in direct contact

with the pipes will be well and profitably spent. Remember it will be difficult, if not impossible, to attend to such things after the building is completed. Run the pipes with a fall toward the meter. If this is not possible they must be laid at least level. Where this cannot be done for the whole job it can be done in sections, or the pipes or certain branches be run with an incline to a suitable place and a drip pipe and cock be inserted. These precautions are especially necessary when gasoline gas is used, or any gas which is simply a vaporized fluid, sure to return to its original form on application of cold.

If there is a plan to work to, study it carefully before beginning operations. Ascertain the relative position of the different openings one to another, and be guided in proportioning your pipes by what may be expected from them. A large room will certainly have a large gasalier hung from its center drop, and while ⅜ inch may be, as a rule, considered right for ordinary drops, it would not do to fit so small a pipe for a ballroom or reception hall. Use common sense. If you have it not, get it as soon as you can. A celebrated painter was asked with what did he mix his colors in order to get the beautiful effects characteristic of his work. His reply was—brains. That's it; brains are what is wanted in the gas fitter's head. If he has not got them in the regular way, then he had better quit the business and go at something where mere muscle is all that is necessary.

A plan was mentioned. The usual plan a gas fitter has to work to is the ordinary building plan, showing the lay out of the various apartments, with a small cross or circle in certain places that stand for the gas openings. A plan showing the various sizes of the pipes

and the way they are to run is something the writer has yet to see coming from an architect's office. He generally covers his retreat by inserting a clause in his specification that reads: "The gas is to be run to the various halls, rooms, passages and other apartments as shown on plans. Pipes to be of iron, well put together, screw joints and red lead. To be perfectly tight. The whole in accordance with the gas company's rules and regulations."

Such being the case, the gas fitter had better mark the pipes in the plan for himself. Having done so carefully, study the situation, then proceed to mark on his sizes. Gas companies' rules do not always work out right. Having thoroughly studied the plan and got into your head what is expected, take your plan and go round the building and with chalk mark the different positions on the walls, floors or studdings. By the time this is done any fitter of ordinary intelligence should be ready to commence the actual work of fitting the pipes.

Gas Fitters' Tools.

This brings us to the question of tools for ordinary jobs. A kit of piping tools from 2 inches to ¼ inch will suffice, consisting of the different stocks and dies, the latter right and left, and suitable tongs. Some form of dies that make the thread with one cut are the best, and the ordinary piping tongs will give the best results. Too much time is lost in new work in handling shifting tongs. A couple of pairs of each size tongs from ¼ to 1 inch are desirable in a good kit in order that one pair may be laid aside for repairs while the other is in use. It does not pay to handle pipe with tongs that have lost their shape or edge by use. There are some forms of dies better than others; those that

while making a full thread by being once screwed on to the pipe, permit of adjustment, and sharpening when necessary, are the best. A good vise with a sure grip jaw and a quick working thread is indispensable, also a bench on which to put it. The handiest bench for a gas fitter is one made of iron pipe of such a size that it can be easily carried in a wagon and be handled by the fitter and his helper. This bench, shown in

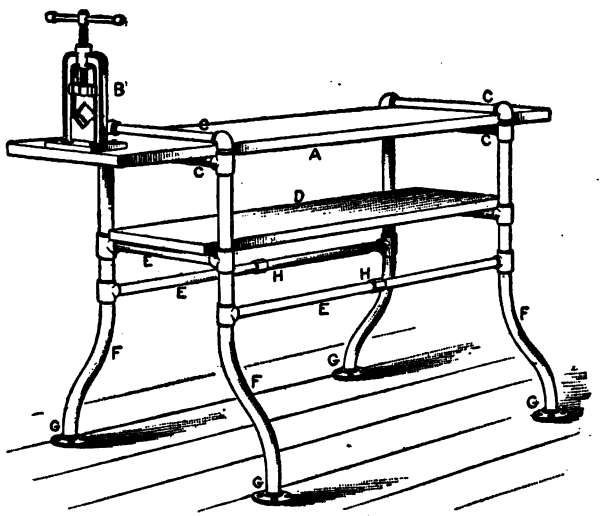

Fig. 13.—Gas Fitters' Bench.

Fig. 13, can easily be made by the fitter and will be much better than sticking the vise on a board and supporting it on a couple of boxes or a barrel, or any other makeshift device, or screwing the vise to an upright plank jambed between floor and ceiling, or securing it to studding, as is frequently done.

In the sketch, Fig. 13, A is a 1½-inch plank, about 1 foot wide; B, vise screwed to plank (bolted); C C

C C, cross pieces of 1-inch gas pipe put together with right and left screwed pipes and fittings, just wide enough apart to receive plank A snugly; D, plank laid on lower cross brace E, and is handy to lay tools on; E E E, cross and longitudinal braces, put together with right and left threads for securing and bracing the legs F; G, flanges that may be screwed to floors when necessary. When it is desired to have a long bench, right and left buckles may be inserted at H, which permits of the bench being handily separated. An ordinary bench will be strong enough if made with 1¼ pipe for the legs, the braces to be ¾. For heavy work the legs may be made of 2-inch pipe and the braces 1¼-inch.

In addition to the ordinary pipe tools a tape line is necessary; also a good handy saw and a lock saw and an assortment of chisels and jumpers for cutting into and through walls and wood work, a long gimlet such as bell hangers use, and, where beams are to be bored, a ratchet brace and an assortment of auger bits, such as are used by steam fitters. Should floors have to be raised a specially made floor lifting chisel is desirable. It must be made of good steel, the blade 2 inches wide and the handle 1 foot 6 inches to 2 feet long, as shown in Fig. 14. A chalk line and a strong tool box with a good lock and key are indispensable; also a handy step ladder.

A very serviceable tool for making the smaller sized holes through brick walls, when bricks are not too hard, is made from a piece of iron pipe, the end being enlarged (made trumpet mouthed) and the edges notched. This tool, Fig. 15, when struck with a hammer and constantly revolved, soon makes a clean hole through an ordinary brick wall. But care must be

exercised when the wall is nearly pierced not to knock out a brick from the side of the wall opposite which the work is being done. This is a very handy tool for use on old work, as it saves smashing of plaster. It is not, however, of much use for pipes over ¾ inch, being too clumsy beyond that size. A similar tool made out of thin brass pipe serves to clear away plaster from around a nipple or drop that it is desired to remove and that has been plastered in. In the latter case it is simply

Fig. 14.—Floor Raising Chisel.

Fig. 15.—Wall Boring Tool.

turned by hand. A gas fitters' torch and blow pipe is useful in applying gas fitters' cement. At one time it was customary to put all the joints together with cement, but of late it has been abandoned. The cement joints required great care and time, and unless well made were liable to be cracked and cause leaks. But the cement is very useful in making repairs of small leaks or putting together the parts of gasaliers and for similar operations.

Piping the Building.

We will now suppose the gas fitter arrived at the building, ready to set up his bench and begin operations. A few minutes' friendly chat with the foreman carpenter, who is generally in charge of the building at this stage, is in order to ascertain where to set his bench, as it will only result in loss of temper to find out after time has been spent in getting ready that you have taken space pre-empted by some brother mechanic, or where you will be in the way of some operation of which you were ignorant. Avoid passages and doorways, and have an eye to convenience of handling your pipes and other materials with plenty of light and room.

Having established your headquarters, take your plan and mark off the positions for the different light and other openings with chalk on the walls for brackets, and on floors for centers. The general hight for placing wall brackets on walls is 5 feet 4 inches from the floor. In halls or passages, 6 feet 6 inches, and in fitting the latter due regard must be taken of the hight of ceiling. The light should never be placed nearer than 2 feet clear of ceiling, if of plaster, and if of wood 3 feet at least must be allowed, and even at that distance a suitable shield must be suspended over the burner.

Next cut the different holes, chases in walls, notches in beams, and generally clear the way. Some architects will only allow pipes to be fitted on top of the beams in notches cut for the purpose. Said notches are generally cut close to the walls, or a bearing point of the beams, so as not to weaken the strength of the building. In cutting notches cut them in line, using

your chalk line, or anything handy, to serve as a straight edge, and be careful not to notch deeper than is actually necessary to allow the fitting of the pipe snugly, but not too tight, or so shallow as to allow the flooring to rest on the pipe. Where beams have to be bored use the same precaution to get holes in line, and avoid making them too large. A hole that will allow the buckles on a pipe to slip through snugly is right. Cut chases in brick walls, using a thin bladed sharp cold

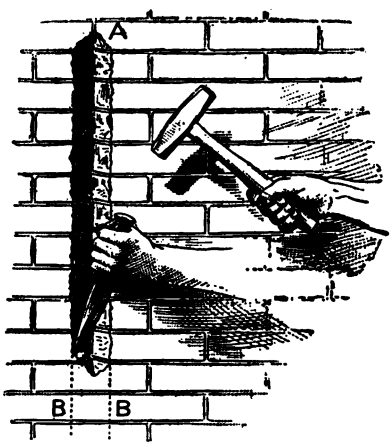

Fig. 16.—Cutting Chase in Brick Wall.

chisel, and cut from the top down, so as to avoid smashing the brick. The operation is shown in Fig. 16, A being the chase cut and B B the lines on the wall to work to.

Having all holes and chases cut, it is next in order to begin the measuring—but I may say, before going into that question, that in many places the gas pipes are run below the beams, in the space formed by the

laths when nailed to the furring. This, in my opinion, is the best plan, causing less disturbance and cutting of the structure, and reducing the risk of the pipes being disturbed by subsequent operations. A sectional view is shown in Fig. 17, A and B being the finished and rough floors respectively, C the beam, D the furring, F the lath and plaster, G the gas pipe and H the drop nipple through the center piece. When this plan is adopted great care must be taken to properly secure the drop nipples to avoid having the weight of the gas-

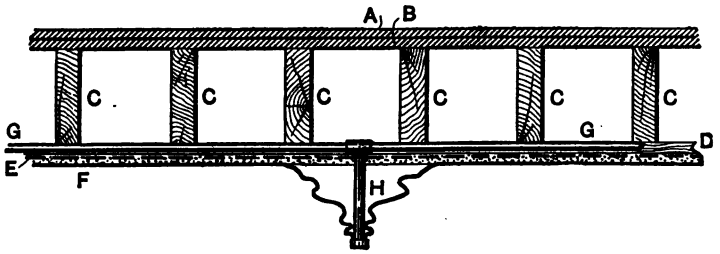

Fig. 17.—Running Pipe Below Floor Beams.

aliers dragging on the laths. Hundreds of houses in the writer's town are fitted up according to the foregoing method; in fact, it is the universal plan, and there are no practical objections to it, although the question is sometimes raised, " How are you going to get at the pipes if they go wrong ? " Well, properly fitted pipes don't go wrong, so there is no sense in raising objections of the " if " species.

Measuring Pipes.

Before taking measurements the fitter must know what sizes and lengths of pipe are correct and allowed. The gas companies in the different cities have different rules.

As an example of the practice in the United States respecting sizes of pipes, I give the following table from the regulations of Washington, D. C., which were adopted in February, 1893:

Size of pipe. Inch.	Greatest length allowed. Feet.	Greatest number of burners.
⅜	6	1
½	20	6
⅝	40	20
¾	60	35
1	80	60
1¼	150	100
1½	200	200
2	300	300
2½	450	450
3	600	750
4		

Smaller pipe than ½ inch shall not be used for ceiling outlets, except for lighting halls, pantries, washrooms, bathrooms and kitchens.

The following is an example of Canadian practice:

Size of pipe. Inch.	Length allowed. Feet.	Number of openings.
¼	6	1
⅜	20	3
½	30	6
⅝	40	12
¾	50	20
1	70	35
1¼	100	60
1½	150	100
2	200	200
2½	300	300
3	450	450
4	600	750

There are a number of plans in use among gas fitters for their guidance in taking measurements. Some measure length of pipe only, some pipe and fitting, outside to outside, but the best plan is to measure from center to center—center of one fitting to center of the next, or center to center of holes. In a complicated building there is an advantage in making a rough pipe plan as the measurements are taken, but in most cases

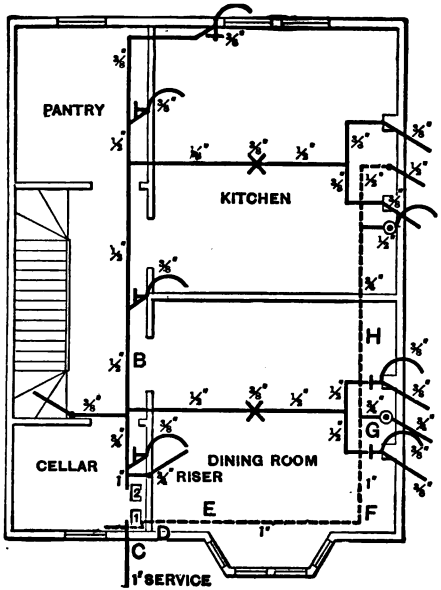

Fig. 20.—Plan of First Floor.

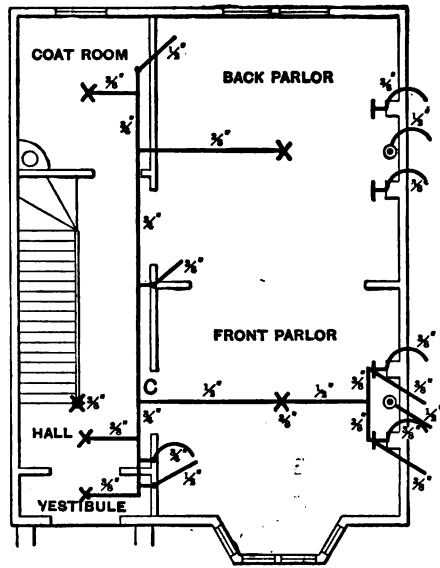

Fig. 19.—Plan of Ground Floor.

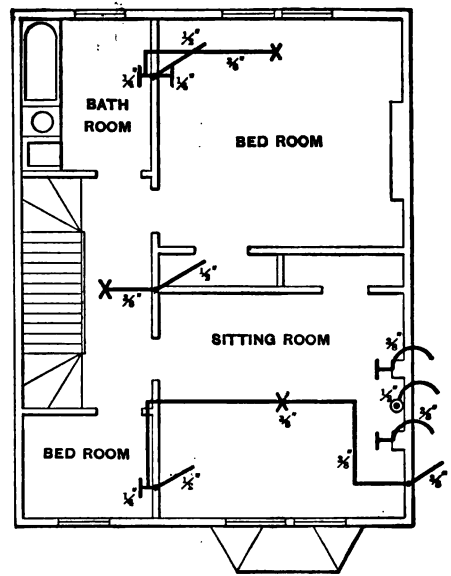

Fig. 18.—Plan of Basement.

Lighting Gas

Cooking and Heating Gas

Bracket Lights

Center Lights

Cooking or Heating Gas

' Feet

" Inches

Signifies Pipe goes up

Signifies Pipe goes down

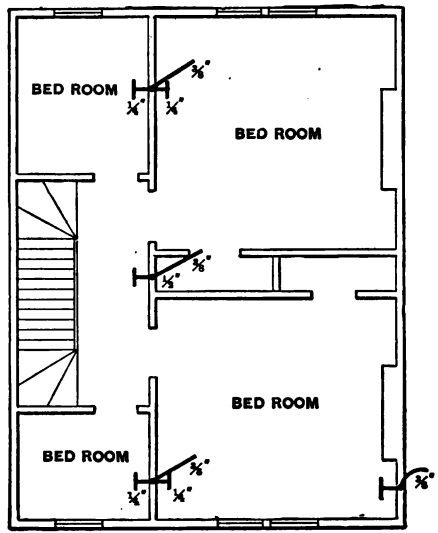

Fig. 22.—Plan of Attic.

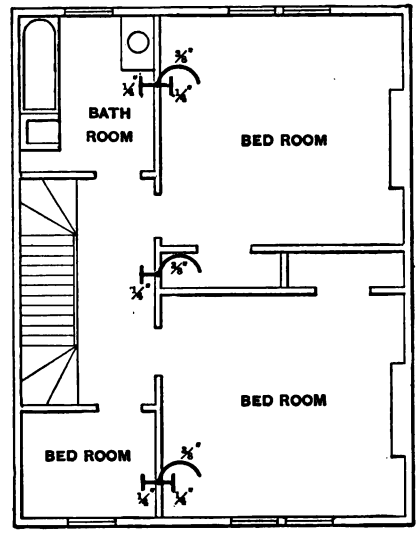

Fig. 21.—Plan of Second Floor.

simply putting down the measures with the size and kind of fitting is all the fitter needs. If there are a great many measurements it is a guide to number the lengths, not necessarily all of them, but making a figure or mark from time to time to serve as a key or reminder. Some measurements only require to be taken once and simply repeated under the same head, such as upright pieces from a running or horizontal main to a bracket. Drop nipples, or wall nipples, also come under this head, but any plan to avoid going over the ground more often than is necessary will serve the same purpose. There is no rule without its exceptions, and this is where brains come into play.

Figs. 18, 19, 20, 21 and 22 are plans of the different flats of a house with the gas pipes and their sizes marked on. Two sets are shown, one with dotted lines, Fig. 18, which supplies the gas required for the grate fire in the dining room, also the stove in kitchen, with branches taken off and rising to supply grate fires in front and back parlors on ground floor, Fig. 19, and grate in first-floor sitting room, Fig. 20. The meters are shown on basement plan, numbered 1 and 2. The line of pipe for heating gas begins at meter No. 1, crosses the dining room and turns toward the kitchen. Opposite the dining room fire place a ¾-inch branch is run off, which is divided to supply dining room fire place, with a ¾-inch pipe continued up to front parlor, where it is again divided, or branched, a ½-inch pipe being run to supply front parlor fire place and another of same size continued up to supply first-floor sitting room fire place. Continuing from the point opposite basement dining room chimney, where its branch was taken off, the pipe is reduced to ¾-inch and run to supply cook stove in kitchen with ½-inch branch, and ½-inch

run up to supply the fire place in the back parlor. Where on the plan branches continue up to a story above they have been shown by a line run at an angle; when the pipe goes down from any particular story the fact is shown by a curved line, as explained in the legend on page 43. Pipes shown in solid lines, Fig. 18, are for lighting gas.

The plan is sufficiently clear and self explanatory not to require a detailed description of all its parts. But to give the reader a fair start in studying it a portion of basement will be described. Starting at meter No. 2 with a 1-inch pipe, it is run as far as where the ¾-inch riser is taken off to supply the upper flats, the fitting used being a 1 x ¾ x ¾ inch T; then a short piece is run with a ¾ x ⅜ inch T, from which is taken the pipe for bracket light for cellar, which drops down, as shown by the curved line. Continuing on ¾-inch, there is a ⅜-inch branch run up to supply the light on newel post of stair on ground floor. Then is taken off a ½-inch branch, which is run across the dining room with a ⅜-inch center drop and continued in branches, as shown, to supply two bracket lights on the chimney breast of dining room, and run up for the same purpose to front parlor chimney. And so on for the different main runs and their branches through the plans.

A set of measurements as taken by the fitter for, say, the heating gas, employing the plan of putting the different sizes of pipe under their proper heading for sizes—that is, not mixing them up—and designating the size of each piece separately, would look like the following, the lengths being of course fictitious and not actual measurements, and the fittings shown as they come in the plan:

1 inch.	¾ inch.	½ inch.
C 1.0 ell and cap.....	G 2.6 ½ x ¾ T.....	6.0 ell.
D 2.6 ell.....	H 10.0¾, ½ x ½ T..... ...	1.0 ell.
E 10 ell.....	.....	0.6 cap.
F 4.0 1 x ¾ x ¾ T.....	....	2.3 ell.
.....	..... .	1.0 ell.
.....	.....	0.6 cap.
.....	.....	2.6 ell.
....	.....	6.0 ell.
.....	.....	1.0 cap.

To make the foregoing still clearer a portion of the pipes on the plan have been designated by letters C, D, E, F, G, H. A verbal description of this portion of the set of measurements is as follows: C shows the piece that will drop through the ceiling at meter, having a cap on one end, which will be removed when final meter connections are made, and an ell (elbow) on the other end, making the turn in which the pipe D will be screwed. D also has an ell on it as well as E. F again changes the direction toward the chimney, and is, say, 4 feet long, having on it a T which changes the size from 1 inch to ¾ inch in two directions. G is ¾ inch in size and has on it a T ½ x ¾ inch for supplying the fire place in dining room, and so on through the whole plan. The letters are used simply to make the method understood by the reader. The resourceful fitter can adopt any plan that is most to his taste, once he has grasped the general idea.

Cutting the Pipe.

The holes being cut and the positions of openings clearly marked on walls, no mistake can be made, especially if the method be adopted of measuring from center of hole to center of hole every time. The measurements being all taken, hang up the plan close beside the vise where it can be seen without unnecessary trouble, and you are ready to begin getting out the

lengths, the helper picking out the fittings as called for. The fittings should be picked from plan and a list of them made out so that they may all be selected in the shop and brought to the building. A tape line is handy for measuring at the vise, and another handy scheme is to have a strip of wood at the side of the bench and laid off in feet and inches, or the side of the bench itself can be so marked. Cut all the same sizes of pipe first, and before taking out of vise screw on the fitting required, first looking through the pipe to be sure that it is clear and examining the thread to make certain the cutting of pipe or thread has not split the end of pipe. Before screwing on the fitting run around the thread with the red lead brush, the red lead being mixed to the consistency of cream. Do not put red lead inside the fittings if small. For fittings 1 inch or over a little lead put inside the fitting does no harm, but for small pipes it is best to avoid the practice. As the pipes are cut and the fittings screwed on they can be laid aside preparatory to being carried to the different floors where they are to be fitted. In screwing the different lines up in final position be careful not to injure the pipes with the tongs, and avoid forcing the pipes too far into the fittings. The pipes being all in and capped, before putting on the final fastenings apply the test pump and make sure the job is tight. Then make the final fastenings, taking great care to have the nipples stand out perfectly horizontal and the drop nipples set plumb. Where side nipples are fitted for an ordinary light, single burner bracket pipe hooks, as shown in Fig. 23, for holding the uprights are all that will be required.

On brick walls use wing elbows and screws. For centers use wing tees or elbows, as the case may require. Where the nipple or drop comes between

studding or beams, nail in a piece of board to which to secure the outlet, as in Fig. 24. On brick work let in a piece of wood, removing a brick and wedging in a block of wood in its place, as shown by the shading in Fig. 25, being careful to have the piece thoroughly wedged in, so that it will not work loose on drying. Driving large nails tightly between the wood and brick is a good method of doing this.

Remember that nipples and drops may have to be taken out for cutting, and when the fixtures are being

Fig. 23.—Fastening Pipe for Side Light.

put up see that they are so arranged that this can be easily done and that the pipe to which they are attached will not spring away. A great deal of removing and cutting of nipples can be avoided if care is taken to allow the proper projection of nipple beyond the line of finished plaster or wood work. About ¾ inch will suit for most fixtures. In some places bent pipes are insisted upon instead of a fitting and nipple or drop. When this is done the greatest care must be taken to see that the projection beyond the finishing is just

right, as there is no screwing out of the nipple under such circumstances.

Having fastened all pipes apply the pump for the

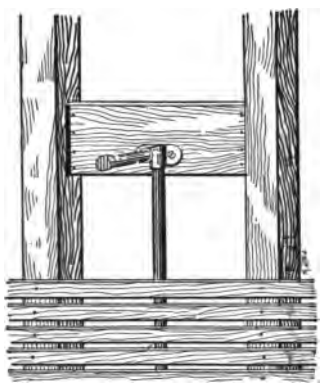

Fig. 24.—Board Between Studding for Holding Nipple.

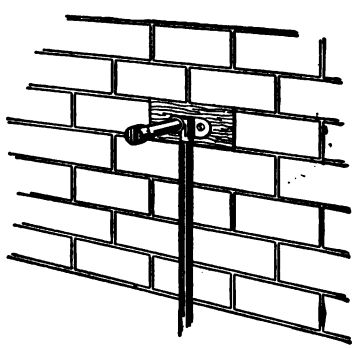

Fig. 25.—Fastening to Brick Work.

final test. If tight, look your work over carefully and pack up for the next job.

Finding Leaks.

If the application of the test pump reveals the unpleasant fact that the job is not tight, it will be necessary for the fitter to hustle to find the leaks. Should the rapidity with which the gauge falls after being pumped up demonstrate that the leak is a large one, but little time or trouble is likely to be required in finding and remedying the defect. First go over all the caps and see that none of them is loose and that no nipple or drop has been left out. All the time the job is being gone over keep the ears open, and have the pump steadily worked, as the sound given off by the escaping air will frequently locate the trouble. For this reason it is well to test during the dinner, or before or after working hours, when comparative quiet will reign in the building. If all caps and nipples are found properly secured, then look for splits in the pipes, the usual place for such defects being where the tongs have gripped the pipe in screwing up. If the gauge falls very slowly, demonstrating the leak to be a small one, there will be much more trouble in finding it.

One method of locating the leak is to mix a quantity of strong soap suds, and with a clean brush generously apply the mixture over the surface of the different pipes, at the same time watching carefully for the bubble that will be blown, from even a very small leak, by the escaping air. It will, of course, be understood that during all these operations the pump must be kept steadily working. Another method is to pour into a cup on the pump, provided for the purpose, a quantity of ether, in this case the nose being the organ used in the hunt, the fitter carefully going over the pipes, smelling for the ether that will escape from the leak.

This method of finding a leak in an open building is somewhat uncertain and tedious, but is frequently used with success.

If the gas service is in and permission from the gas company be had, service and house main can be connected and the nose may be assisted by a lighted taper in the search. If the lighted taper is employed great care must be exercised to guard against setting the building on fire, as the very small flame likely to result from a little leak may not be perceptible to the eye, especially in the daylight. Or the flame may be at the back of a fitting in some inaccessible place, beyond the reach of eyesight. It is a good rule to test with a light in no place that cannot be easily reached to blow out any flame that may result, and further, when there is a strong odor of gas a light must never be put into confined places, such as between floors or behind partitions. This especially applies to searches for leaks in finished buildings, for by so doing the fitter may have an explosion added to his troubles.

Sometimes it is possible to fill the pipes with water and locate the leak in that way. This is a risky business, however, as it is very difficult to empty out all the water, especially from the smaller pipes, and may cause trouble for months. The writer, nevertheless, has known fitters who did not hesitate a moment in adopting this plan, it being a certain and rapid way of finding leaks. When following this plan, however, the proper way to empty the pipes of water is to take off the caps on the nipples and drops that are highest. Then remove the caps on the lowest drops and nipples and on the main, blowing violently several times into each nipple on the upper or top flat. Then take the caps off the next lower flat and blow into all the pipes

on that floor, and so on down, keeping at it until there is no uncertainty as to the pipes being entirely emptied of water. They can then be left for a few days and the blowing out process repeated. This method of finding leaks is, of course, out of the question in cold weather.

In fitting up large buildings it is a safe plan to test the work in sections—say a flat or two at a time—leaving suitable connections for joining all the parts tested before making the final test of the whole job. Having found the leak, there comes up for consideration the question of making effectual repairs. A split pipe or fitting must be removed and replaced with sound material, but a small hole in a fitting may be closed with gas fitters' cement, the fitting being first well heated by means of the blow pipe and lamp and the cement applied to the attachment while hot. An escape at the screw thread may also be firmly closed with cement or with red lead well rubbed in.

Putting Up Fixtures.

When the building is nearing completion the gas fitter will be called up to attend to the hanging of the gasaliers, putting up brackets and connecting gas stoves and fires. Should it devolve upon him to assist in the selection of the fixtures, he must be guided by the requirements of the case, not only as regards the lighting, but also the suitableness of the different fixtures, forming as they will very prominent parts of the furniture and decorations of the apartments.

In large centers such work is usually attended to by the architect, decorator or cabinet maker, but in small towns the average customer will appeal to his gas fitter for assistance. It will be impossible to lay down definite rules for guidance in such cases, but certain gen-

eral principles must be kept in mind. Small rooms, such as upstairs sitting rooms or boudoirs, will require lighter fixtures than the larger rooms, such as parlors and dining rooms. The fittings must also be somewhat in keeping with the general style of the house finish and decoration, both as regards color and style. It by no means follows because only one light is required in a room that a single light gasalier must be selected. A two, three or four-light lamp in many cases will be much more suitable as being more symmetrical and appropriate to its general surroundings. Should a fixture be required for the newel post of the stair, it must be in keeping with the general style of the post of which it will form a part. Swinging brackets must never be selected to go on wooden partitions or be chosen for places where they are liable to be swung under shelves or against doors or other wood work. For closets and similar places an ell cock, screwed on to the nipple, will generally be found to fill the bill, etc.

The length of gasaliers is an important matter. Hights of ceilings must be taken, measuring from the bottom of the center to the floor, it being usual to hang gasaliers in ordinary apartments 6 feet 4 inches clear of the floor. For halls 6 feet 6 inches is a general hight, for mirror lights 6 feet 2 inches and in stores fixtures generally hang 6 feet 6 inches to 7 feet clear of the floor. Some judgment must be used in even so simple a matter as this. In rooms where people are going to dance 6 feet 4 inches would not be sufficient, as a tall man might in dancing strike them. Fittings that have to supply light for reading, sewing and similar occupations require to be lower and nearer the work than if required for occupations requiring less light.

The gas fixtures having been selected and made to length, it is the fitter's duty to see that they are tight. This is done with sufficient exactness for small fixtures by exhausting the air by means of the lungs, and if the tongue adheres firmly to the fixture after the air has been sucked out the fixture may be accepted as tight. But it is not sufficient to merely feel that the tongue adheres, a short interval of time must be allowed to elapse before the tongue is removed; as, for a very small leak, adherence will take place at the moment, but the entrance of air by the leak will speedily release the talking organ. Having made sure the fixture is tight, next make certain there is no stoppage in it. The simplest way of doing this is by blowing through it, not with all the cocks open, if it is a fixture of several burners, but shutting off all but one, then shutting the one tested and opening another until all have been tried.

Gas fixtures should be put together with gas fitters' cement, which is a sort of rough sealing wax, made as follows: Take 4½ parts of good clear rosin, 1 part beeswax, 3 parts venetian red. Melt and thoroughly mix. Then run into sticks on a marble slab or piece of iron or any similar substance, to which it will not adhere when cold. It is applied by thoroughly warming the parts on which it is to be used to such a temperature as will cause the cement to flow freely. Then apply by rubbing an end of one of the sticks to the heated parts and screw up while hot. The spirit lamp and blow pipe are generally used for heating. It was at one time customary to use gas fitters' cement in putting together the pipes in a building, and it may still be the custom in some places. The objection to it was the time it took, the greater care required and the brittle-

ness of the joint after being made. Heavy swinging brackets that are liable to turn down if swung to the right side for unscrewing are best put on to the nipples with cement, or, better still, a back plate can be used, which will be screwed to the wall by ordinary wood screws, and the bracket screwed to the plate by a pinching or set screw.

Having made sure that the fitting is both tight and clear, next put on the burners or jets. See that they are set straight, and if the burner is to serve as a fastening to the globe holder or gallery, see that the thread on the fixture is long enough to allow the burner to be well and safely screwed on. This is another place where great care must be used to prevent an escape of gas, and cement does not answer the purpose, as the burners will, in most cases, get hot enough to melt the cement. Good red or white lead, so mixed that it will not run, is best for use at such joints. Specially made washers can also be had which serve the purpose admirably, being set at the base of the burner. When an escape of gas is complained of after the gas is lighted, it will be found in many cases to come from the joint at the base of the burner, sometimes in sufficient quantity to smell badly, but in too small a quantity to light. The fitter must not suppose because he cannot get a flame at a joint that it is perfectly gas tight, as a keen nose will find an escape sufficient to cause a very unpleasant odor in a room, when the gas is not escaping enough to light on the application of a flame. Set the jets in the burner so that the flat part of the flame will be toward the direction in which it is desired the light shall travel.

The burners being on, you are now ready to hang the fixture, as it is called—that is, to screw it to the

drop. The drop must be cut to a proper length in order to have a neat joint at the ceiling, properly covered by the ceiling piece, leaf or cap forming the top of the fixture. Screw up the fixture firmly, and caution the people of the house against twisting it for a few days until the red lead has become properly set, unless cement has been used, which will make a rigid joint as soon as cold. Very large fixtures should further be made safe by having a set screw run through the top

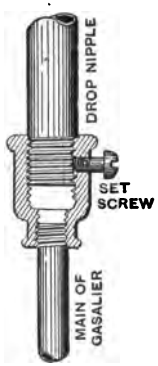

Fig. 26.—Set Screw Fastening.

socket, which must be set tightly against the pipe, as shown in Fig. 26.

Having screwed up the fixture, see that it hangs straight (plumb), and don't leave it until it does. See that the arms are parallel with the body, or rather stem, of the fixture; that the globe holders are set level, and that the ornaments generally are in proper position and have not been disturbed by the hanging up operations. In putting up large fixtures it is sometimes of advantage to strip them of a portion of their ornaments, such as chains and pendants, and trim the fixture after

the stems and arms are up. Having the fixture in position, the last thing to be done is to put on the globes. See that they are firmly secure, so that a jar or shake will not knock them off. When all the fixtures are up turn on the gas and go over the burners, lighting every one. See that they are properly set as regards the flame; that they are clean, giving a flame of perfect shape, and, above all, that the flame does not come in contact with the globes.

In putting up fixtures in low ceiling rooms, smoke bells had better be suspended over the jets. When this is done it is best to have them secured by suitable devices to the fixture, as it is not always possible to get a holding for a screw in just the right spot on the ceiling. When they must be suspended from the ceiling use very thin screws that will go into a lath without splitting it. Nearly all English made gasaliers are provided with a ball and socket joint at the top, the American practice being the reverse, except for special fixtures.

Ball and socket joints should be provided for all large fixtures. When used see that they are well greased with good tallow, and secure them to the nipple with a set screw. Also see that the two parts of the ball joint are secured with a set screw, as ball jointed fixtures are supposed to be moved and turned about, and unless firmly secured by set screws an ignorant or careless person is very apt to unscrew them by turning the wrong way. They should always be turned in the direction that would screw up or tighten the joint, should it happen to be loose. The set screw precaution is especially necessary when crystal gasaliers are in question. A weak spot in crystal gasaliers is the plaster setting—that is, where the crystal parts are set into the metal, plaster of paris being usually employed for

making the joint. Rooms in which old crystal gasaliers are hung are apt to smell of gas. This will generally be found to proceed from the setting. In time the gas saturates the plaster and is given off in many small but distinctly perceptible quantities. It is sometimes possible to cure the trouble by carefully painting around the setting with white lead or white shellac varnish, but when fixtures get into the aforementioned condition they should be taken apart and the joints reset.

Having made sure that all your burners are right, fitting plumb and level as the case may be, ornaments

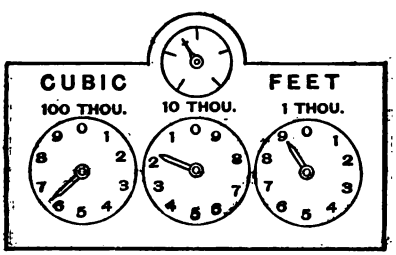

Fig. 27.—Meter Dial Plate.

in place, and that no red or white lead is in evidence where it should not be, no finger marks on the fittings or globes (I take it for granted that the fitter has not marked the walls or ceilings), and that all litter has been cleared up, it is in order again to test the job. This time it may be done by means of the meter. Mark the position of the index on the meter dial—the top dial on the metal index (see Fig. 27). This dial and pointer serve to mark the single feet and parts of feet of gas passing through the meter and the pointer travels comparatively fast. If its position is marked

and all cocks being shut it is left for a short time, say 15 minutes or half an hour, and it remains in its position as marked, the job may be passed as tight. It is well in new work to test the meter by opening one or two cocks and lighting the burners in order to see that the meter is in working order, and watching the indicator hand. Also light up all the gas at the same time in order to ascertain that there is a free delivery of gas in sufficient proportion at each burner.

Gas Logs.

The gasaliers and brackets being connected and tested, it is next in order to attend to the connections for the gas fires and stoves. The points to be observed are, first, as to the setting of the gas logs or basket grates. When logs are used, or grates of the movable kind, care must be taken to have them set properly in the fire place, central as regards the width of the fire place, and far enough back to insure the free escape of the products of combustion up the chimney flue. The throat of the chimney should not be left full open, but should be provided with a metal stopper having in it an adjustable damper that can be entirely closed when no fire is used, and having a notched ratchet attachment by means of which the size of opening in the damper can be regulated.

The cocks for controlling the supply of gas to the fires must be so placed as to be easy of access when the fire is burning. They are sometimes fitted by the man who pipes the house under the flooring and outside the hearth at one side. In such cases a socket key must be provided to pass through the floor for turning the cock. Again, they may be placed above the floor, outside the fire place, at one side of the mantel. When it is neces-

sary to have them immediately under the grate or log, they must be provided with a key long enough to clear the front of the log or grate and be attached to the cock. Gas stoves are generally provided with cocks for controlling the different burners, but must have in addition an independent cock on the main supply to the stove for shutting off the whole apparatus. A suitable hood should be fitted over cooking burners, having a pipe connected to the nearest flue for carrying off the fumes of cooking, and when the stove is provided with a collar for vent flue the pipe from it may be attached to the pipe from the hood leading to the flue.

Fit keys in these pipes and try all burners, seeing that all the heat burners give the proper heat flame (blue), otherwise they will give poor results, forming soot on the bottom of cooking vessels and giving off foul odors. When gas fires are used, requiring the white or light flame, see that all the holes in the log or fire are free, and that the gas ignites at all of them, so that unconsumed gas may not escape. Where imitation coal fires are used by piling lump asbestos in a grate over a suitable burner or set of burners, see that the lumps are so arranged as to give the effect of a real coal fire, and to this end, when the lumps are perforated, pile them over the burners in such a way as to permit the gas and flame to pass freely through the openings. A little asbestos fiber judiciously arranged among the lumps adds very much to the general effect.

Economical Gas Burning.

In concluding the series of articles on gas fitting, it will be in order to give a few general hints on the principles governing the burning of gas for illuminating purposes, in order to obtain the greatest amount of

light with the smallest possible consumption. There are six general principles covering this important part of the question that should be thoroughly understood by the gas fitter:

1. The pressure at which gas is burned (delivered at the burner).

2. The sizes of pipes and their freedom from obstruction.

3. The sort of burner used in order to obtain the best results.

4. The kind of globe or shade used.

5. The temperature of the gas.

6. The presence of air in the gas.

Regarding the first principle, pressure, gas should not be used under a greater pressure than that required to insure a steady and uniform flow from the burner, just enough to spread the flame and no more. For gas of ordinary quality this should be 5-10 inch on a water gauge. Consumption is increased while the light is decreased by using gas at a pressure beyond this. The following table gives the results from an actual test made by "The Referees," as embodied in their report to the London (England) Board of Trade:

Relation of Gas Pressure and Illumination.

Pressure at burner.	Number of feet used per hour. Feet.	Illuminating power (candle).	What illuminating power should be.	Loss per cent.
4/10	5	16.00	.....	..
8/10	7.80	8.67	25.05	25
12/10	10.00	21.77	32.00	32
17/10	11.66	18.66	37.31	50
21/10	13.33	17.06	42.65	60
30/10	15.00	16.80	48.00	65

The foregoing figures tell their own story. The pressure at the burner is governed, first, by the amount of pressure maintained at the works. Gas companies

usually deliver gas at the lowest pressure that will enable them to send the gas to the furthest points covered by their system of mains. It is to their interest to do this; as it lessens their percentage of loss from leaks, which is always large. But this pressure may be higher than it is desirable to use at the burner.

The pressure at the burners may be regulated in several ways: 1. By partially shutting the main cock at the meter. 2. By adjusting the cock at the burner. 3. By fitting an automatic governor at the meter. 4. By using automatic governing burners. The regulation of pressure by the first and second methods is always unreliable and annoying, as the pressure in the mains is always varying, owing to the constant shutting off and turning on of gas in the neighborhood or even in the house, and cannot be depended on to give anything like satisfactory results. The automatic governor at the meter answers the purpose admirably, but care must be taken in selecting a suitable governor. Many of those in the market, while excellent as regards their governing properties, are thoroughly unreliable in the materials of which they are constructed and cause annoyance from leakage after being a short time in use. Governors that have the valve worked by a metallic or glass float, sealed in mercury, are the best, not being liable to get out of order. Very high buildings should be so piped that a governor could be placed on each story for controlling the lights that supply it, as the higher the building the greater the pressure will be at the top, the increase in pressure for hight for ordinary illuminating (coal) gas being about one-tenth for every 10 feet of additional hight. For domestic purposes it is best to use some form of governor burner that is automatic in its action. There are a number of them in the

market, one of which the writer knows to be thoroughly reliable.

The second heading, sizes of pipes and freedom from obstruction, has been treated in previous chapters. The third refers to the sort of burner to be used, and it is very essential that a proper burner should be used. The results of a test made some time ago in Birmingham, England, of over 50 different kinds of burners proved beyond question that the worst burner gave a light equal to 6.44 candles, and the best equal to 20.32 candles—that is, the best burner gave over three times the light of the worst, using exactly the same quantity of gas and under the same conditions. Another common error is the supposition that small burners must of necessity be more economical than larger ones, the object, of course, being to get the largest amount of light at the lowest rate, and it becomes of exceeding importance to use the proper size and kind of burner. The following table of the result of tests made with the latest improved argand burner tells the tale:

Gas Consumption and Candle Power.

Gas per hour. Feet.	Number of candles (light).
2.1	2 01
2.8	5.47
3.3	8.25
4.0	12.00
4.4	13.77
5.0	16.00

The foregoing shows that the burner using 5 feet of gas per hour is the most economical, when the quantity of light derived from the gas consumed is considered. It is by no means to be supposed that there is economy in using a 5-foot argand in a place where a 2-foot lava tip would give all the light required, but the principle is what I want the reader to understand. Quoting from an eminent authority:

"People feeling the pressure of the times and wishing to economize in their expenses put on small burners, thinking if they reduce the flame they will keep down the gas account. Never were they more mistaken, for instead of decreasing their bills they only decrease their light and pay more for it. Instead of doing that, if they would reduce the number and use larger burners and burn their gas at a low pressure they would accomplish their purpose."

Burners require to be kept clean, and when the flame shoots up several points it indicates that dirt has become lodged in the opening, and unless it is cleaned the amount of light is diminished, while the quantity of gas consumed may remain the same. Rubbing with a brush will sometimes remove obstructions, or it may be necessary to employ a wire. A hairpin answers the purpose admirably for burners having circular openings. For burners having a slit opening a piece of thin cardboard or thick paper may be used in the absence of a regular burner cleaner. A flame rather sluggish in appearance gives the greatest amount of light, as it allows the carbon in the gas, which is the light giving medium, time to come thoroughly in contact with the blue or heat portion of the flame and be rendered incandescent. A flame that has a very large proportion of dark (blue) in it is a good flame for heat but a poor flame for light. A first-class heating flame gives little or no light.

Fourth.—The kind of globe or shade used has an important bearing on the light question. The shape, material, color and method of support are each important factors. The diameter of the bottom opening should never be less than 4 inches. It must be large enough to allow plenty of margin for the free play of

air without causing a flicker in the flame and with a full sized opening on the top. The object is to prevent a draft of air being brought in contact with the flame, which will cause it to flicker and give an unsteady and annoying light. Globes with a large bottom opening

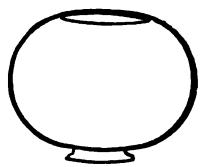

Fig. 28.—Globe with Contracted Openings.

and parallel sides, as in Fig. 29, are the best. A very poor style of globe, once very common, is shown in Fig. 28. Massive globe holders or supports must be avoided, as they obstruct the light and free passage of air as well as throw shadows. The simple three-

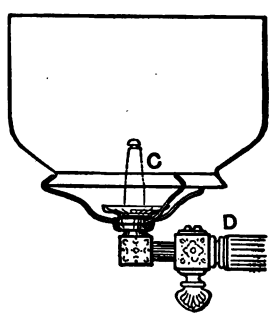

Fig. 29.—Globe with Parallel Sides.

pronged wire holder is the best for bottom support, as shown in Fig. 29. All globes or shades obstruct the light. The following table is the result of actual tests by an eminent expert:

Loss of Light by Shades.

Description of glass.	Loss of light. Per cent.
Clear glass	10.57
Ground glass	29.48
Smooth opal	52.83
Ground opal	55.85
Double German ground	62.34

These figures show the loss of light horizontally through the globe from the flame and need no comment.

Fifth.—The temperature of the gas also has an important bearing on its light giving properties. When the temperature falls below 60 degrees F. it is injurious, proving the necessity of care in selecting warm positions for the different pipes and mains. Experiment has demonstrated that a reduction of temperature from 60 degrees to 32 degrees reduces the illuminating power of the gas from 20 to 25 per cent., and when the temperature falls as low as 5 degrees the light is reduced 60 to 70 per cent.

Sixth.—The presence of air in gas reduces its light giving properties very much, proving the necessity of having all pipes and fixtures tight, as the following table shows:

Loss of Light From Air Admixture.

Per cent. of air.	Per cent. of loss of light.
1	6
2	11
4	26
8	67
10	68
15	80
..	98

There are many points of interest in connection with the practice of gas fitting that might have been alluded to in the foregoing chapters, but it was not the intention to write an exhaustive scientific treatise on

gas and gas fitting, but only to touch upon such points as were likely to be of use to the ordinary gas fitter in the daily practice of his trade. If I have succeeded in helping one weak brother over a rough place I am amply repaid.

PRACTICAL GAS FITTING.

Second Article.

BY W. B. GRAY.

Practical Gas Fitting—II.

Introductory.

Those of wide experience will perhaps find little that is new in this article. To those of less experience, or even those with long experience who have not adopted a definite mode of procedure, it will doubtless furnish some interesting information.

Every gas fitter has some little peculiarity in commencing and executing the work of piping a house for gas. The slight differences that may be detected in the results of gas work thoroughly executed, but by different methods, will not be considered here. It is the using of proper fittings, pipe, etc., in proper places that claims the gas fitter's attention, and when these points receive due attention the fitter may rest assured that the result will be favorable. Let the thoughtless fitter remember the following: That it is a waste of time and material to use one T, one elbow and one nipple where one three-way elbow will do better; that in some places a long pattern drop T will answer instead of a T and nipple; that a service L is equivalent to a nipple and elbows; that there are many little facts of a like character in gas fitting worth more attention than they receive. Figs. 1, 2, 3, 4 and 5 illustrate the fittings mentioned above.

Locating the Lights.

We will suppose that an ordinary dwelling house is ready for gas pipe and that a fitter has been sent to do the work. The first thing to be done is to locate the

lights. If the plans have been marked the fitter has only to follow the plans, unless the owner changes her mind. I may state here that women generally have more voice concerning where lights will be placed in dwelling houses than men have. When a lady betrays that she is not positive whether a light will give her more satisfaction in one place than in another, the fitter who has enough confidence in his own ability to venture the following suggestion will never be found on the bottom terrace of success. In such cases the fitter may state very modestly that not considering any especial

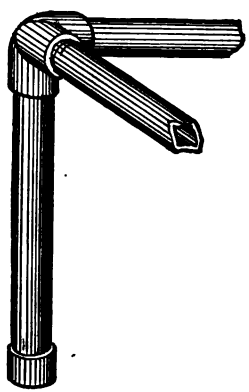

Fig. 1.—Three-Way Elbow.

feature she may desire in the lighting, he is more familiar with what will give satisfaction than any person who is only called upon once or twice in a lifetime to decide such questions. If the plans have not been marked, and the fitter when consulting the owner is given the privilege of locating the lights, he will not place a light without reasoning with himself as to where it will do best. By continual reasoning and reflecting

on former experience the mind will indicate certain positions for certain lights as standards, and what has before been the most annoying task of gas fitting will soon become as easy and pleasant as any other part of it.

However, the fitter will find freaks of minds most painfully apparent in modern "gingerbread" dwellings, to which no rule can conform. In such cases the fitter may use his judgment, and feel assured that those who can sacrifice the comfort and convenience of a house's interior to give it a striking external appearance can also endure an ill lighted house if necessary.

After the fitter has obtained all the necessary infor-

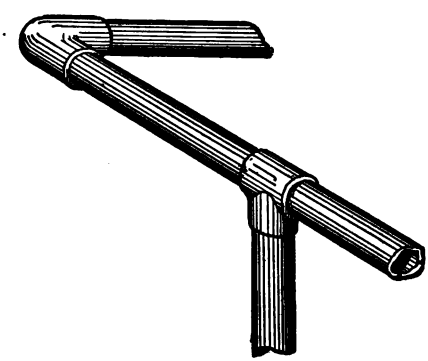

Fig. 2.—Elbow and T.

amtion he will probably spend twenty minutes in giving the building a general survey and comparing the various partitions, etc., with the plans. If he finds a partition that does not correspond with the plans, or in fact anything that would throw a light out of center by centering from the main walls according to the scale on the plans, he makes a chalk mark to remind him when measuring. A chalk X mark is also made (by guess)

about where the lights will be in every room in the house. These X marks serve as reminders. When the true center is found by measuring, a X mark within a circle is made. The kitchen should have a drop for center light and an opening for a bracket over the sink. If there is no sink, it may be over the place most likely to be occupied by the table, and about 5 feet from the floor. The china closet, storeroom and pantry should have center lights, because the shelves occupy the spaces where brackets might otherwise be placed. Very small dining rooms need only a center light, but large dining rooms need more, say a bracket light on

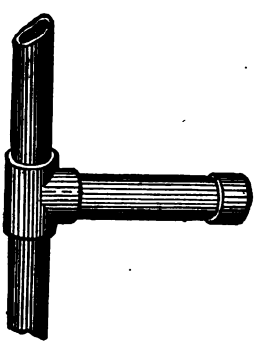

Fig. 3.—T and Nipple.

each side of the china board. Where the china board is to be stationary and extra long the bracket lights may be placed over the mantel, unless the doors of the china board are so arranged that a light may be placed in the frame. The library should have a center and bracket light. The owner should be consulted about placing the bracket light, that it may suit the desk to be used. The parlor may have a center light and

others if they are desired. The family room should have center light and bracket lights in the most convenient places; if placed over a mantel that is to have a cabinet the openings should be on the side instead of the face of the jamb.

Bracket lights are to be recommended for dressing case lights, as they do not interfere with placing or removing the case and are not in the way when cleaning the mirror. They should be placed about 5 feet from the floor. An alcove should never have a center light, but a bracket light placed midway between the

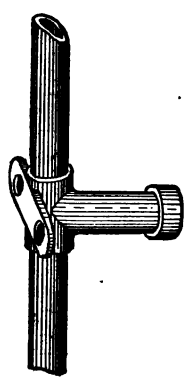

Fig. 4.—Long Pattern and Drop T.

arch and window facing of the alcove is very convenient in case of sickness, when a light is often needed near the bed. There is no objection to placing center lights in bed chambers with low ceilings, except that they blacken the ceiling quicker than bracket lights do. Bed chambers with high ceilings may have both center and mirror lights. Some people read a great deal in bed, and the fitter should ask the owner about the location of

a light for that purpose. Second and third floor halls, if narrow, may be fitted with bracket lights 6 feet from the floor, and always on the same side that the door is, nearest the place the light is required, for the reason that all the space opposite a door in a narrow hall is needed to turn furniture. Very wide halls, with high ceilings, may have center lights. Water closets and bathrooms of small dwellings may have side lights 6 feet from the floor. Extra large bathrooms may have both center and side lights. In small buildings that have a curtain arch in front of the stairway, for the purpose of using that part of the hall as a reception hall, a center light may be placed in space before the arch

Fig. 5.—Service L.

and the stairs lighted by a newel post light. Such houses usually have a stove in the rear of the front hall, and a bracket light should be placed 6 feet from the floor, midway between the door facing and side wall. Stairs having a landing and return can be lighted by a bracket placed 6 feet above the landing floor, if no header stands above. Attic halls and rooms need only bracket lights. The room lights should be near the door, to avoid stumbling over what is sure to find its way there. The laundry should have a center light and bracket over the tubs. The furnace or boiler room should have a light placed where it will shine on the steam gauge, water glass or regulator, as the case may

be. The coal cellar should have a bracket light near the door, that it may not be broken by pitching in coal. The fitter should ascertain which rooms, if any, are to have center pieces of plaster, and make the drops long enough to extend through them. The reader will bear in mind that there are exceptions to all rules, and be prepared to use his own good judgment when necessary, as the best of rules are worthless without judgment.

Locating the Meter.

Special attention should be given to locating the rising main, which in ordinary dwellings is generally placed in a wood partition to avoid channeling the wall. It should be as convenient for the gas service as circumstances will allow. As placing the rising main determines where the meter will set, let us compare the results of setting meters in different places. Meters are almost invariably placed in the cellars, which is probably the best place for them in dwellings, for this reason: All gas pipes should be slightly inclined, either toward the fixture or meter, preferably toward the latter. A meter can very easily be placed below all the lights when in the cellar, and should condensation fill its wells it does not have to be carried through the house to be emptied. Meters are sometimes placed in the stair closet, which is the next best place in a dwelling compared with the cellar. People are often troubled with flickering lights when the meter is in the closet, for the reason that the newel post supply is a continuation of the riser and receives the condensation from the entire house. In such cases the newel supply should be taken from the side of the riser, and a large drip, say 2 feet of 1-inch pipe, placed in its lowest point. By this method the

drip receives only the condensation from the newel supply, while the meter receives it from the balance of the house.

I will here give a modest hint to the reader about emptying drips. If by accident the contents of a drip

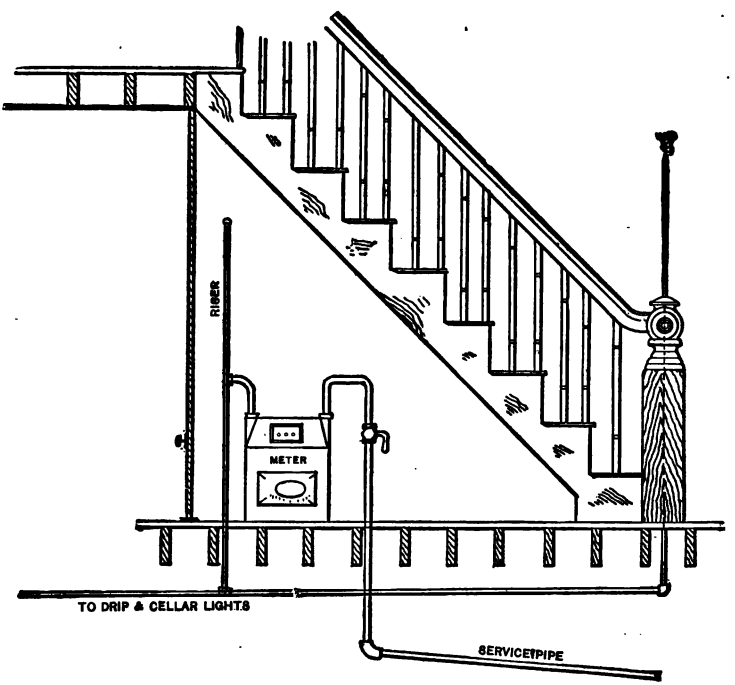

Fig. 6.—Riser and Newel Post Light.

are spilt, keep flame away from it. If you suspect that a gas meter contains water, shut off the gas and disconnect, and take it to a place where the odor will not disturb the household before emptying. I have seen gas fitters uncap meter wells to discover whether the

trouble was in the meter or not (when looking for water traps), thereby spilling some of the water. Now, as the odor of such water is most persistent and offensive, and has caused many fruitless searches for gas leaks, it is advisable to be careful with it. Fig. 6 shows a good arrangement for riser and newel post light when the meter is in the stair closet of a house having only a small cellar in the rear. The engraving shows the meter connected to the side of the riser, which continues below the joist far enough to allow a rise to the newel post. As shown, a pipe is continued from this point to the cellar, with a gradual fall, where it terminates below the branch for cellar light in a large drip fitted with drain cock.

Making the Plan.

After all the necessary lights are located a plan must be made and the correct measure of each piece of pipe marked under the line representing it on the plan, to enable the fitter to work with speed and accuracy.

Gas fitters' working plans are like everything else in one respect—there are many ways to make them, but only one proper way. Perhaps every good gas fitter thinks his method is the best. Those that do think so are not altogether wrong, because a man who has followed one plan for years, no matter how faulty it may be, has become familiar with every defect, and has cured all its failings with some little tricks of his own, which makes it appear to him better than any other way. Such a man will not usually gain for himself by changing; but should he be convinced that there is a better way for those who are not already tied to some method by force of habit he should adopt it for the benefit of his apprentices.

Apprentices and those who have no definite methods will do well to consider everything pertaining to the business that comes before their eyes, in order to form the best habits in the beginning. With the aid of the engravings the following description will give the reader a good idea of what is, to the writer's mind, a rapid method, and one very easily comprehended. One of the most essential points of a gas fitter's plan is proportion, if it can be made so without wasting more time than the advantage of such a quality is worth.

The best plans are obtained by using linen tracing paper, from which any number of blue prints can be made afterward, but the cost of such prevents its use, except upon special occasions. Probably the easiest and cheapest manner of proportioning a plan is to get a piece of white wrapping or other suitable paper of ample size and lay it upon a smooth board. Then lay the first floor plans upon it, fasten the two in position by sticking tacks or pins through two or three of the outside wall corners. Now stick through the plan into the paper below with a pin, at the places marked for gas, remove the plan and twirl the point of a lead pencil in all the pin holes, except those at the wall corners. The second floor plans may now be placed on the paper in the exact position that the first floor plans were, by sticking through the holes at the wall corners corresponding with those made to secure the first plans. Always fasten by the outside wall corners, because they have no offsets to be watched. When the second floor plan is placed, stick through all the places marked for brackets on the second floor. The pin holes made for bracket lights on second floor are not marked with a pencil and may be easily distinguished from those for the first floor.

The plan is now ready for lining and includes all the lights on first floor and the bracket lights on second floor. Second floor bracket lights are included on first floor plan because it saves running a larger pipe to second floor ceiling. It also saves pipe in the upright runs to brackets. For example, say there are eight bracket lights on the second floor of a house with 13-foot ceilings and that the average distance of lights from floor is 5 feet. The pipe saved by supplying the brackets from first floor will be 32 feet, not considering that the second floor rising main, etc., may be made eight lights smaller in capacity by so doing. It must be remembered that a wall pipe dropped from an upper floor must cross the joist, while one run up the wall has the advantage of starting from the top of the joist. When lining the plan all lines representing horizontal pipes are drawn at right angles to or perpendicular to each other except where offsets or curves occur. All lines representing vertical pipes which hang below the plane of horizontal pipes may be drawn at an angle of, say, 45 degrees to the left of the person drawing, and toward the end of the plan marked "front," which end should always be next to the person drawing. Lines which represent vertical pipes that stand above the plane of horizontal pipes may be drawn upward, or from the end marked "front," and 45 degrees to the right of the person drawing. The general effect of lining a plan as described may be seen in Figs. 7 and 8.

Vertical pipes for brackets may be drawn ¼ inch to the foot, with some exceptions, as, for example, we will suppose there are six bracket lights 6 feet high and six 5 feet from the floor. By drawing the six 5 feet from the floor only 1 inch long and the others 1¾ inches, the difference in length will aid the eye in sing-

ling out all the pieces required of any certain length, that they may be measured and checked at the same time. As there are no long lines in a gas fitter's plan it may be drawn with the pocket rule, which will show

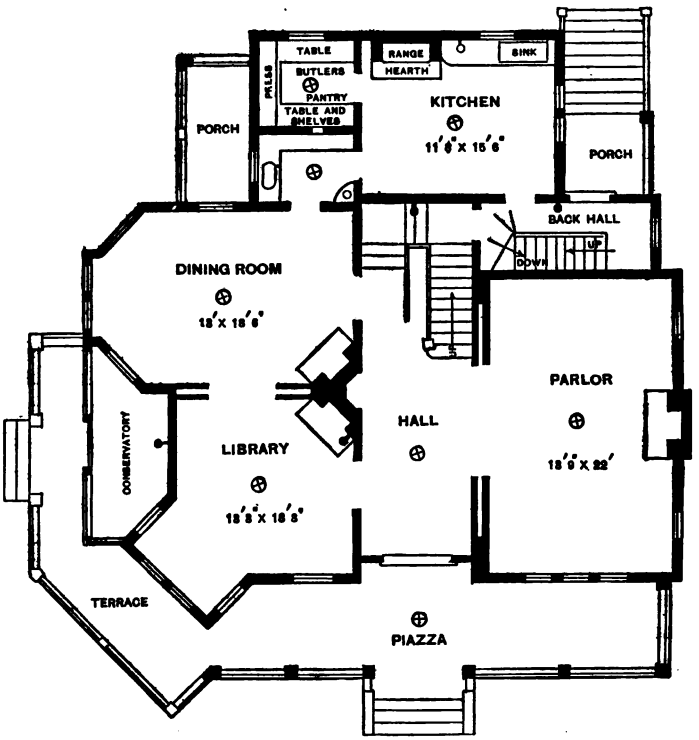

Fig. 7.—Plan of First Floor of House.

by the graduations when the line is the proper length. The fitter should be careful to " route " his plans in such a manner that the large pipes will cross the joists near walls or headers, or run between joists. Cutting

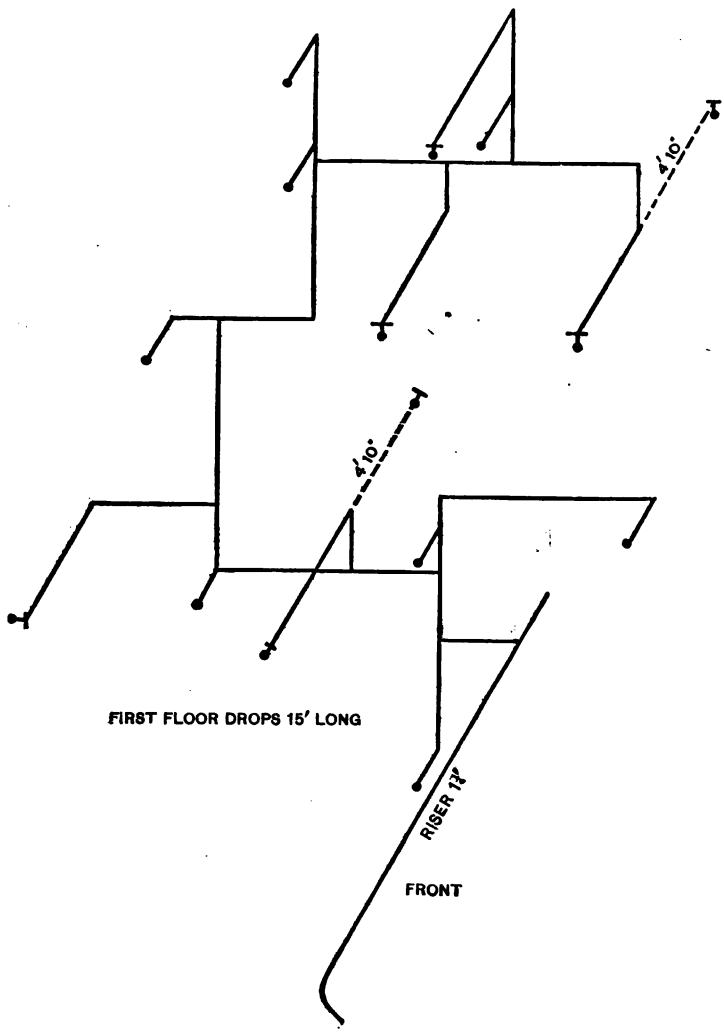

Fig. 8.—Plan of Pipes.

walls should be avoided when possible, often by running the pipe through doorways.

The better plan, when measuring a house for gas, is to measure the house instead of relying on the plans, because the rooms will have to be centered to tell where to fasten the drops, and by doing this when the plan is made the trouble of having drops and other branches come on top of joists is avoided. When the center of a room or hall is found to be several inches from a joist, a chalk mark may be drawn down the side of the joist nearest the center, as many inches in length as the center is from the joist, as shown by Fig. 9. When fasten-

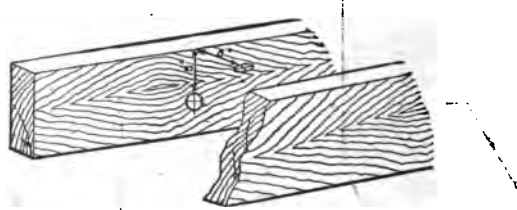

Fig. 9.—Center Marks on Joist.

ing the drops, the length of this line will show the distance of the center of the room from the joist one way. The position of the line on the joist will show the center of the room the other way.

The fitter should be careful about the following points when measuring: Do not forget to make allowance for sliding doors when there is only one of the partitions in place at the time of measuring. Be sure that the helper is holding the tape to the right place while measuring a room to find center, if there is an offset in the walls commencing at the ceiling. When measuring, see that the helper does not mistake the X mark, made as a reminder, for the positive center (an X within

a circle). Take care to put the figures under the lines representing the place measured.

The plans for the second floor center lights and third or attic floor brackets may be obtained by following the directions given to make the first-floor plans. The fitter should be careful not to place drop pipes or branches in the bottom of long lines of pipes, as it is better to place them on the side or top. However, the cost of taking such extra precaution is greater than the benefit derived from such work in general dwellings, for the reason that dwellings are kept warmer and at a more uniform temperature than business houses are, and offer no extra inducement for gas to condense or take up moisture; also any slight condensation would be dried up by the heat in the building.

When the plans are all drawn they should be compared with the house plans to ascertain whether any lights have been omitted or not; also to see whether the right number of brackets and center lights show on the gas plans. Should all the plans prove correct the other work may proceed. After the fitting is finished these plans should be filed for future use. If settlement causes a pipe to break or leak the plans will show just where to find it. If owner wants an extension made and comes to the shop to know what it will cost, an intelligent estimate can be given. The fitter can tell by the plans where the pipe is, what size it is and what fitting is needed to secure the opening. There is no unnecessary cutting of floors and no extra trips made. The fitter just puts the proper fixture, a length of pipe, some fittings and a kit of tools in the wagon, goes out and puts up that extension while a man without such reference would be wondering what board the pipe was under.

Getting Out the Pipe.

To cut the pipes the proper length and size is no less important than any of the other features of gas fitting. When the pipe is cut and fitted in the building, sometimes a portable bench is used, but for ordinary

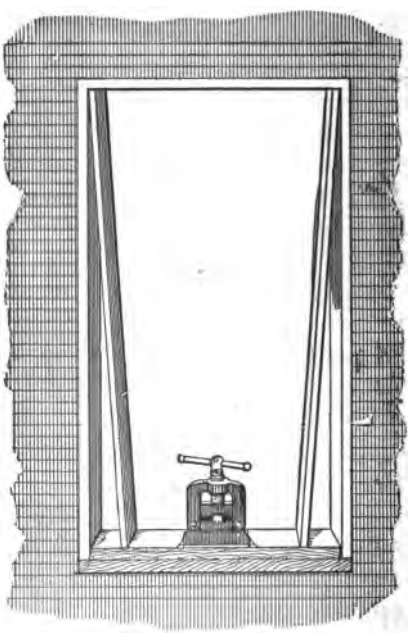

Fig. 10.—Pipe Vise Braced in Position.

work the vise may be bolted or lagged to a piece of 2 x 8 inch stuff and braced up in the most suitable place about the building. Fig. 10 shows the vise ready for work. It should be of the pattern that opens and closes by clutch and be reversible.

Before any pipe is cut the fitter had better deter-

mine about what size he will use. The following table is the standard of the sizes of pipe allowed for the given number of lights by the principal American gas companies:

Size. Inches.	Length allowed. Feet.	Number burners.
¼	6	1
⅜	20	3
½	30	6
¾	50	20
1	70	35
1¼	100	60
1½	150	100
2	200	200

There is a considerable margin for variation in the above table, which may be seen by comparing the following figures:

Size. Inches.	Friction surface in 1-inch length.	Number burners allowed.
¼	0.785 x 1 inch area, 0.050	1
2	6.283 x 1 inch area, 3.141	200

The distance that gas has to travel through a given size of pipe must also be considered. For example, it is known that 2,000 cubic feet of gas will pass through a 2-inch pipe in one hour, with a loss of 5-10 inch pressure, while only 700 feet will pass through 500 feet of 2-inch pipe in one hour with the same loss of pressure. For dwelling houses of from 3 to 7 lights, no less than ½-inch risers should be used; for from 7 to 12 lights, ¾-inch riser; for from 20 to 30 lights, 1¼-inch riser.

The following may be adopted as standard rules: Make all center openings ⅜ inch, unless for extra heavy fixtures or those with more than 8 burners, when they may be made ½ inch or more, according to circumstances. Branches in the rear of a house that are to supply a center light and bracket may be made ⅜ inch. Branches supplying a parlor or other gasalier of more than 4 lights besides one or two brackets should

have a ½-inch supply to first branch or to center opening. All bracket uprights should be ¼-inch pipe. The fitter will find that it is better to make all pipe under floors as large as ⅜ inch. It is not to be inferred that the above sizes will not furnish gas to more burners than specified when in good condition, but there are many chances that a small pipe will become clogged, and the sizes should be held up to the rules in general.

While the fitter is getting everything in readiness to work in earnest the helper usually gets out the drops and bracket pieces. There are so many patterns of gas fittings that a reliable table of allowances to be made for fittings cannot be given. The best way to bridge this difficulty is for those interested to spend a leisure hour in measuring and noting down the allowances to be made for the several kinds of staple fittings. Ater a little practice the mind will recall the allowance instantly. A boy cannot do better than spend his odd hours in comparing the amounts of the different sizes of pipe used in gas fitting, as shown by the plans on file at the shop, for the purpose of learning the proportionate amount of each size used. He may also note the various fittings shown on the plans and determine the proportion of each kind used. Even the boy who has energy enough to do this will never appreciate the knowledge gained by it until he is called upon to select the fittings and pipe for a country or suburban job, and not then unless he is going to do the work himself.

A good reamer should be kept handy to ream out the burrs caused on the side of the pipes by the cutter. If this is not done the smaller pipes are often reduced as much as one-third of their given capacity. If the dies used have to be changed for every different size threaded, time will be saved by finishing one size before

touching any other, or at least get one thread on each piece and the proper fitting screwed on loose. When adjustable dies are used it does not make a great deal of difference whether one size is adhered to until finished or not, although the writer prefers to do so, because the allowance for only one kind of fitting is on the mind at a time, as well as other advantages. When threading small gas pipe the rule of cutting full threads will have to be broken sometimes, because a factory thread will "butt" in an elbow before it gets tight. Solid dies that are cut deep or without much taper will make a thread which will "butt" or come to a shoulder before getting tight. Factory threads and those cut full with such dies may be used to screw into sockets, tees and crosses, but for elbows the depth of the thread on the pipe should correspond with the depth of the threads in the elbow.

The easiest way to measure gas pipe for a new house is to get a long piece of ¼ round and mark it off in feet, say up to 15 feet. Then lay a long sheathing board across the joists near the vise, and tack a strip across each end of it. The fitter may now remove the sockets from the pipes to be measured, and he is ready to work in earnest. To start with, a glance at the plans shows eight pieces of ¼ inch to be 4 feet 10 inches long. They are for bracket uprights, and the total allowance to be made for both fittings is ¾ inch. Four lengths of ¼-inch pipe are now placed on the sheathing board, and evened by pushing the ends against the strip on the end of same. The strip of quartering which has been cut and marked 15 feet is now laid beside them. A pocket rule is now placed at the 4-foot mark and 10 inches added; then mark all four lengths at once and chalk each piece needed.

Without turning a length the other ends may be pushed against the other strip and four more pieces marked by holding the rule at 11 feet and marking back 10 inches. The fitter can start all the fittings on the pieces, check them off on the plan and measure other pieces while the helper is cutting off the pieces measured first. This work may be continued until all the pipe is cut.

The fitter may then thread the other ends while the helper changes the fittings to the last thread cut, not forgetting to change ends with the fitting at the same time, which insures that the threads will enter easy when placing the pipe. One of the best points in getting out gas pipe is one that is rarely taken advantage of. Its merits may be learned from the following:

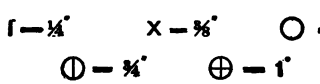

Fig. 11.—Symbols Used in Checking Plans.

Assuming that there is no reason for not doing so, the gas fitter should work from the extremities of a plan instead of from the riser. By so doing, should one size of the small pipe be short on an out of the way job, it will terminate where a larger size may be substituted without trouble; also the checks on the pieces that are to be supplied from any certain piece will show what fitting belongs on it, while by starting from the riser the fitter forgets what openings he left in certain places, and has to hunt up the piece of a certain size and measure before he can tell what size to make the branch pipe. The author recommends the method of checking plans shown in Fig. 11 to those who have no better method.

When the plan is made, no marks except the figures denoting the length of the pipe is placed upon it. The fitter works from one extremity at a time until every piece of ¼ inch is measured and checked. Fig. 11 shows the check marks to be used for the different size pipes; they not only denote that a piece is measured when checked, but show what size it is. Each increasing size is measured and checked, always working toward the riser, until the entire plan is checked. All sizes above 1 inch may have the size marked in figures and be checked with the standard check mark. By

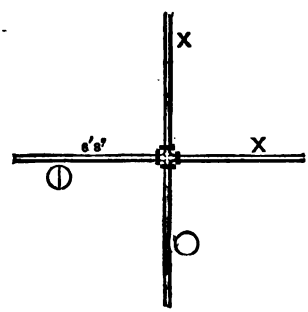

Fig. 12.—Example Showing Use of Check Marks.

referring to Fig. 12 the reader will see how easy it is to determine that the piece marked 6 feet 8 inches is to be furnished with a cross ¾ x ⅜ x ½ x ⅜ inch.

The next step, after every piece is cut and threaded, is to cement the fittings. If all gas fittings were perfect both in thread and casting and pipe threads were perfect cement would not be needed. However, all fittings are not perfect, and many that seem to be would show a defect after the strains they receive by being placed in position. I will describe two of the methods of cementing fittings. The first method con-

sists of heating the fittings just hot enough to broil spittle while they are on the pipe; clamp the pipe in the vise and remove the fitting with the plyers; put a little cement in the threads of the fitting and some on the threads of the pipe, then screw the fitting on moderately tight. Next cover the surface of the fitting with cement and lay it aside to cool. The second and best method is the same as the first, except that the fitting is removed and dipped into melted cement, which insures a perfect coating of cement inside the fitting that cannot be scratched off. Threads may be screwed into branches of the fittings so treated while they are warm to cut out the cement; if this is not done, they will have to be heated again to enter the threads when placing the pipe. Some fitters dip the entire fitting into melted cement after they are screwed on. The writer believes that one flexible joint in a fitting is better than none, and recommends that good white lead or asphalt varnish be used when screwing the pipes into position. It is better to buy cement from the stock house than to make it, as that made by unskilled hands is liable to " run " in warm weather and cause trouble. The pipes of each floor may be kept separate to avoid the extra trouble of distributing from a lot of pipe with many pieces nearly the same length and size.

Piping the House.

The last chapter ended with everything in readiness to place the gas pipe in the building. The reader will remember that the pipe for each floor was kept separate through all former operations. When the different lots have been carried to their respective floors the fitter should, if he has not already done so, blow through each piece to prove that it is not clogged with

cuttings, dirt, or an imperfect weld, and test them by extracting the air with the lungs, in the same fashion that the tongue can be sucked into a bottle. If the tongue sticks firm for 5 seconds on short and small pieces, they may be considered tight. Large and long pieces will require more time to extract the air, and a proportionately longer time for the test, because the larger the space that is void the longer it will take a small hole to restore the internal pressure. Pipes that are too large to be filled with the tongue may be covered with the lips. New pipe can be exhausted very quickly by drawing the air into the lungs instead of drawing a mouthful at a time, but it is bad policy to test old pipe containing rust or gas deposits in that manner. Any pieces that seem defective should be tried a second time to be sure that the helper was holding the end firm. Leaks discovered in this manner may usually be traced to a defective weld or a weld strained by cutting.

Any bend or offset that is required should be made before the pipe is screwed in, that it may be tested to avoid cutting it out should scales clog it or the weld split. There is some difference in the opinions advanced relative to the position that ought to be given to the weld when making a cold bend. The writer believes that if there is any choice of positions it is the neck of a bend. For offsets the weld should stand half way between the neck and side of the first curve. In cases like the following we would not venture to say that one particular place was better than another for the weld. We once had a boss who invariably commenced the day by drinking several " eye openers " and telling us that we should obey orders if it broke the masters. One morning we informed him that we could not make a certain " coil " because the mandrel was loaned. He

ordered us to bend it around the telephone post. It is there yet, because the company will not remove the cross arms that we may lift it off.

When the fitter is sure that every piece of pipe is clear and sound, the next step is to take the plan of the floor he happens to be on and call off the sizes and lengths of the pieces, while the helper, by the aid of the rule and measuring stick, finds the pieces and places them where the fitter directs. When the pieces are all placed the fitter may screw several pieces together loosely and hold them in the exact position they are to occupy while the helper marks the joists to be sawed. It is better to mark the joist by the pipe itself, for then there is no recutting to make fittings match,

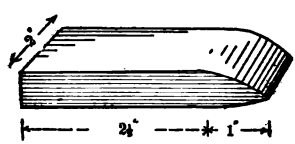

Fig. 13.—Shape and Dimensions of Wedge.

etc. All drops for center lights must be screwed up in cement to prevent them from unscrewing when caps or fixtures are removed. Lines of pipe between joists should be well supported to prevent sagging. Any pipe that cannot be given a fall to the riser should have a fall to the fixture. All pipes should be low enough to allow the floor to go in place without bearing on the fittings. Pipes for lights showing on partitions not yet in place give more trouble than anything else in a new house. If they are left standing the carpenter usually breaks them off while placing his studding. Probably the best way is to put in stubs that will stick above the floor and lengthen them after the partition is in place.

Time can be saved by running the newel light after the post is up. Assuming now that all the pipes are put together, we will give our attention to fastening the drops and bracket pipes. Some wedges that will not split easily (white pine), and of the proper shape, are the first things needed. Fig. 13 will give a good idea of the shape to make the wedges. They should be about 2 inches wide by 3½ inches long, and from ¼ inch to ⅝ inch in thickness. The tapering part or

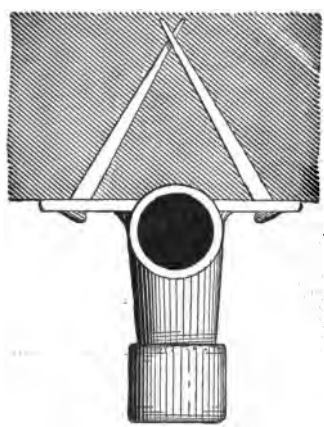

Fig. 14.—Manner of Fastening Drop Ells.

point of the wedge should be only about an inch long and if the grain of the wood converges at all the point should be at the converging end. Wedges should never be placed in the upright seam on a chimney jamb near the corner, because the corner brick will push out and allow the pipe to get loose. Wedging into flue walls should be done very carefully. Fig. 14 shows the best manner of fastening drop L's. Nails driven across the grain (screws are better) do not split the wedges so

easily, and the pipe cannot become loose unless the wedge pulls out. Bracket pipes ought not to be pulled in with hooks, because the pipe will crack the plastering if the hooks get a little loose. Fig. 15 illustrates the method of curving the bracket pipe outward just enough to leave it free from strain at all points except

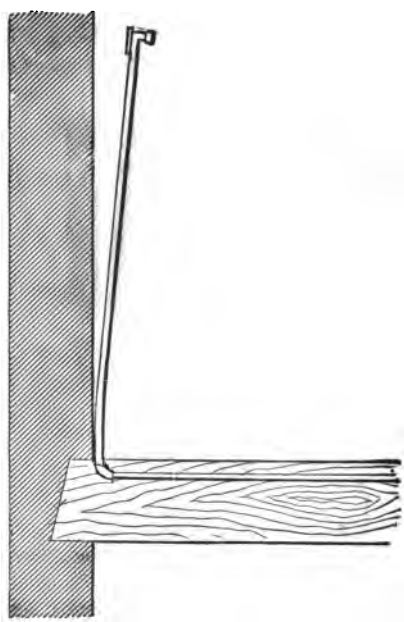

Fig. 15.—Method of Curving Bracket Pipes.

the bracket fitting. By doing this and fastening the fitting very firm there need be no fear that the pipe will crack the plastering.

Fastening drops is so simple that it is hardly worth time to speak of it. Where they come between joists cleats can be nailed on the joists 1 inch more than the

depth of the running pipe from the tip A strip 1 inch thick can then be placed under the pipe near the drop and rest on the cleats. When the drop is beside a joist it can be secured by rabbeting a block and nailing it to the joist, as shown by Fig. 16. Practically there are but two things to be remembered when fastening drops —viz., make them hang perpendicular and fasten them firm.

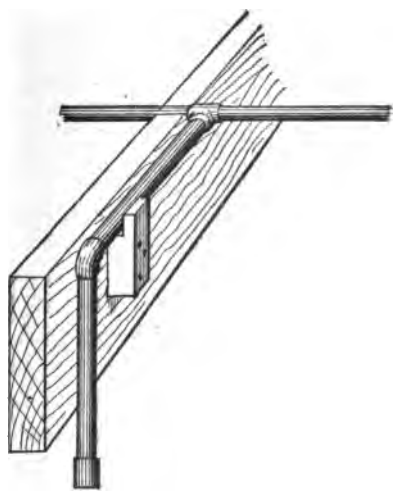

Fig. 16.—Securing Drop to Joist.

The last and most interesting part of a gas fitting job is testing the pipe. The test should be just as rigid whether an inspector's certificate is required or not. There are two kinds of test pumps—the spring gauge and mercury gauge. The reader can see a cut of them by turning to any catalogue of gas fitter's tools. The mercury gauge is the more suitable, because it is more

sensitive than the other. The glass may be placed nearly at the bottom of the cup, in order to use as little mercury as will give the required pressure; then should an accident occur there will not be much lost. A column of mercury 2 inches high is equal to about 1 pound pressure. Eight inches is ample hight for the mercury column when testing illuminating gas pipe, as there is at most only a few ounces' pressure on the mains at any time. The pump for testing may be placed at any convenient opening, and after allowing a moment for the mercury to settle it should stand 15 minutes without even getting flat on the top of the column. Very small houses may be passed with a ten minute test, as the leaks will show sooner. If the mercury falls gradually the leaks are either considerable or very near the pump. If it stands for several minutes and then drops suddenly the leak is very small and usually very remote from the pump. If the pump proves that the pipes leak the pressure may be let off and a little sulphuric ether poured into the opening for the purpose, or into the barrel of the pump. Then pump up the pressure again. A large leak may be smelled and heard too, as soon as you get near it, but the nose will have to be placed close to a small leak to detect the smell of ether; a little soapy water can be used to advantage in hunting gas leaks. If the suspected place is painted with it the air will make a bubble, showing exactly where the leak is. Split pipe and fittings should in all cases be removed. If the fitter has any time to spare when the job is finished he can employ himself by loosening the caps while the pressure is on to see that no pipe is clogged.

Gas Fixtures and Fittings.

The foregoing chapters of this article briefly described the most essential features of the work of piping an ordinary dwelling house. We will now speak of the gasaliers, brackets, etc.

Parlor fixtures of the better class are usually hung by ball joints, the lowest part of the fixture being about 7 feet from the floor. Ball joints are made of brass, and are not unlike the ordinary unions, except that the collar threads are gas tight and that the collar has a set screw to secure it after it is screwed tight. The tail piece is screwed to receive the stem of the fixture, and has an extra large flange, which is ground into the collar in such a manner that it can be moved in any direction as much as 30 degrees from the center line. The advantages of the ball joint are: The fixture will hang perpendicular, whether the drop is perpendicular or not; should anything strike the fixture it will recede instead of breaking off; when cleaning globes or fixtures it may be turned instead of moving the ladder; if a burner does not burn properly the best burner may be turned in the direction where the most light is needed until the burner is repaired. Fixtures swinging by ball joints should always be turned from the person with the right hand, to prevent any possible chance of the fixture unscrewing.

Other appliances are often used instead of ball joints, of which Fig. 17 is a representation. However, ball joints are the best. Fig. 17 is a swing joint made in the following manner: Take a piece of white rubber hose which will fit tight on the stem of the fixture, slip it on about 3 inches and secure it with a hose band; then slip the ceiling plate over the drop and measure

the length of the hose required to slip up to the plate, allowing plenty of hose, to prevent buckling when the fixture swings; cut the hose the proper length and secure it to the drop with a band. This appliance is used in foundries, furniture factories, etc.

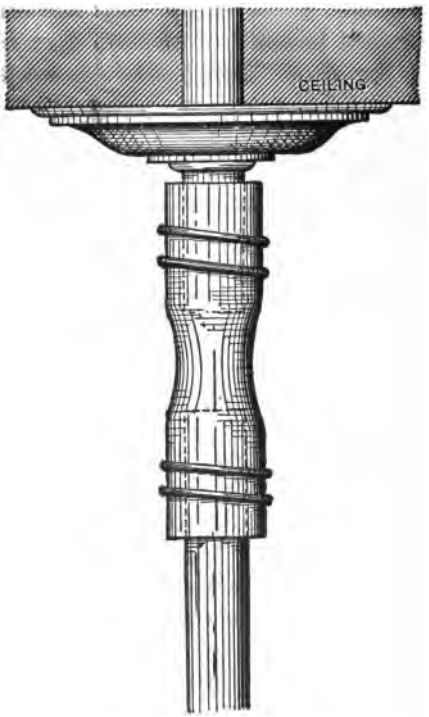

Fig. 17.—Substitute for Ball Joint.

Fig. 18 shows another fitting, used in any place where the fixture must be lifted or removed in order to remove, handle or set up certain work. It has only a vibrating movement and is very easily strained, unless

the drop is perfectly true and will leak then if pushed in any but the proper direction.

There should be at least two sliding fixtures in a house, one in the library, the other in the dining room. There are many forms of slide fixtures, such as packing

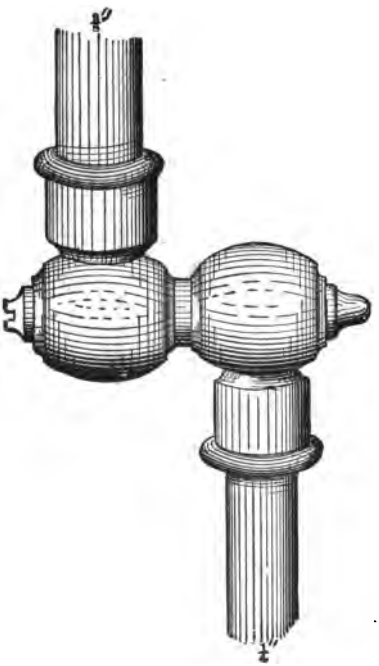

Fig. 18.—Swinging Joint for Drop.

sockets, in which the packing is compressed tight enough to hold the fixture in any desired position, and fit only for use on light single and double pendants; others, with packing sockets and weights to counterbalance the fixture. Wedge and spring joints and friction

ball cases, in fact all slide fixtures, depend upon the packing socket, except the water slide, or, as called more properly, the hydraulic gasalier, of which Fig. 19 shows the construction. The water slide fixture should

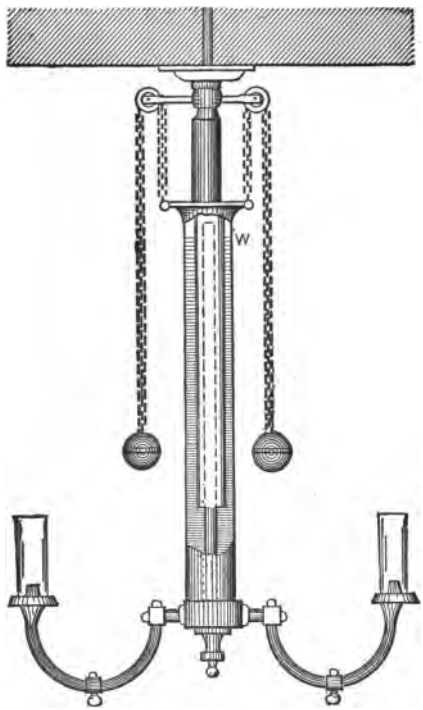

Fig. 19.—Hydraulic Gasalier.

be hung by a ball joint. The fixture is held in position by weights made heavy enough to balance the fixture while filled with water. Persons having water slide fixtures can tell when the water is low by the fixture creeping up, because the fixture alone is not heavy

enough to balance the weights. As shown by Fig. 19 the bottom or moving part of the fixture has two tubes. The central tube connects to the gasway of the fixture arms. The outer tube has a belt shaped upper end, with proper loops for the weight chains, and is fastened to the base fitting, so as to make a uniform annular space between it and the central tube, in which the stationary drop pipe stands. The weight chains must be short enough to prevent pulling the slides entirely out of place. The objections to water slide fixtures are that they look clumsy, and if not watched the water will evaporate enough to break the seal.

Persons owning such fixtures should make it the duty of one particular person to keep the slides filled. The writer recommends that a stop cock be placed above all water slides, in order to avoid the risk of leaving the gas on during the summer months, while the family are at the watering places or summer resorts, and only the servants have charge of the house.

All fixtures should be cemented together with the best quality of cement, especially rope arm fixtures, because the creases in the rope imitations are deeper than the threads. Parts that cannot be heated with the torch without damaging the finish may be heated by screwing a hot nipple into the threads. Fixture lengths should be obtained by measuring from the floor to the bottom of the drop. When hanging fixtures those drops that are too long to allow the fixture socket to hold the plate against the ceiling should have the extra space covered with casing of the same finish as the fixture. Factory fixture stems that are too short should be replaced with one piece the proper length, which makes a neater looking fixture when cased. When a slide is not used in the dining room the fixture may be placed

as low as 6 feet 4 inches from the floor. Those who cannot afford a slide fixture for the library may use the common drop with movable shade. The style of drop goose neck, which hangs inside of globe and through globe holder, is best.

Hall fixtures should be placed about 7 feet from the floor of small dwellings. Large halls may have the fixtures according to the hight of the ceiling. Other dwelling fixtures not mentioned here may be placed 6 feet 8 inches, unless otherwise requested. Dressing

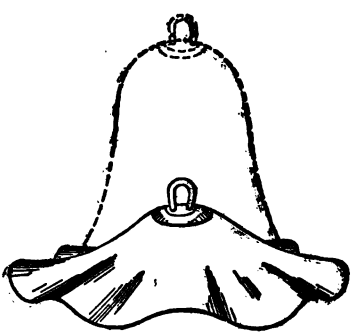

Fig. 20.—Forms of Smoke Plate and Smoke Bell.

case brackets should be of the universal pattern, which can be raised or lowered to suit the person dressing. More satisfaction will be derived from the use of that class of universal brackets which depend upon the friction of the joints to hold them in any desired position than from the use of those that have ratchet wheels or set screw attachments, because force of habit will cause those familiar with common brackets to break a ratchet by a sudden pull when they are not thinking, and persons who are not familiar with gas often think such

brackets naturally work hard and pull until they break them.

As all gas employed for general lighting at present gives off more or less carbon, smoke bells and plates are used to distribute it (not absorb or destroy, as some

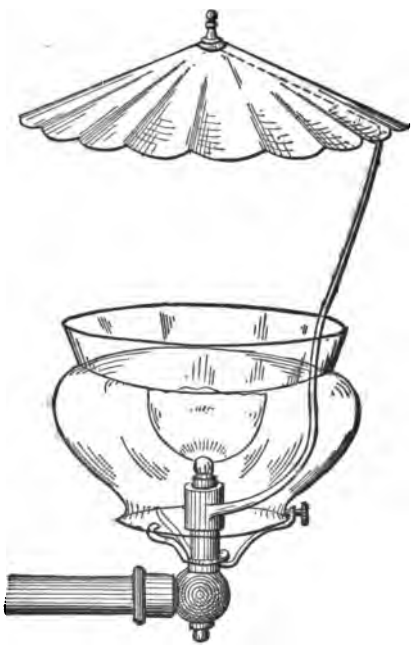

Fig. 21.—Smoke Canopy.

people seem to think), thereby making the effect less visible. Fig. 20 shows the form of a smoke plate by solid lines. The dotted lines in connection with the base of the smoke plate show the form of a smoke bell. Both forms answer the same purpose and the shape is only a matter of taste, except that the bell will hang

plumb when it is a little heavy on one side, while the plate tends to the heaviest side, however slight the difference may be. The writer prefers to have smoke bells or plates hung from arms screwed into a frame which, when slipped over the stem of the fixture, forms a "break" in the casing. There is not always a support over the center of a burner, and when bells are hung from high ceilings the heat causes them to swing too much; but if hung near the support their swinging is limited, and the distribution of the soot more effectual. Bells may be hung from 12 to 18 inches above the jets, according to the fitter's judgment.

Fig. 21 shows the best style of smoke canopy for brackets; they may be used on gasaliers instead of smoke bells. As shown, the canopy is supported by a wire connected to a slip socket which slips over the burner. The advantage of this is that it can be used where there is no globe, or it will stand inside of any globe, while the legged canopies cannot be nicely adjusted to crown or pan etched globes or their modifications, and cannot be used at all without the globe.

Piping Old Houses.

The preceding chapters of this article were devoted to describing the work of piping an ordinary dwelling house at the time of its construction. I will now describe some of the principal points in piping a house already constructed. In every city and suburban district there are many of the better class of dwellings that are without gas and in which the lighting does not meet the requirements of tenants or owners. This state of affairs causes constant changing, extending and fitting of gas pipe in houses already built.

To fit a finished house with gas some ability and

aptitude is required on the fitter's part other than that necessary for ordinary fitting. He may have to remove the furniture, take up and replace the carpets and floors, as neatly as a carpenter and carpet layer could, in order to give satisfaction. The fitting should be very carefully done, especially in cases where the family occupy the house while the work is being carried on, as each room should be completely finished, except the hanging of gasaliers, before another is commenced. This method of working makes it less inconvenient for the household, but gives double trouble in locating and remedying defects. In houses not occupied, where carpets, furniture and floor may be left in disorder until the pipe work is completed, all overrigid precaution may be economically dispensed with, because the time consumed in trying to avoid possible leaks is usually greater than that required to stop the leaks, which may be avoided by extra precaution when the pipes are all accessible at the time of testing.

The following is a list of the indispensable tools for such work: One ratchet brace, one twisted point gimlet, 3 feet long; one twisted point gimlet, short; one 1-inch augur bit, one gouge, preferably of three-quarter octagon steel (hand made); one framing chisel 2 inches wide; one floor chisel, with blade shaped like a hatchet blade; one hand saw, one very thin blade compass saw, one plumb bob, one tape line, one pocket rule, one cold chisel, one hammer, one oil can, one reversible vise, one chisel and one stone drill. The fitter may use his judgment as to what dies, taps, wrenches, etc., he may need. All chisels used to force up flooring boards should have round edges, causing them to mash rather than cut into the edges of the adjoining board.

The first thing to be done is to center the rooms. A

stick 10 feet long marked in feet and fourths of feet is better than a line to measure with, as no help is needed, and the helper may set the vise while you center, first the floors, then the ceilings, by means of the plumb. Rooms having plaster or fancy paper centers need no center marks, because the "drop" must come exactly through the center of the piece. Many rooms have neither paper nor plaster center pieces; such may have the drop exactly in the center unless a joist is in the way, and in that case 1 inch either way to avoid the joist will not look bad. The position of joist above paper or plaster surface ceilings may be known by the light stripes directly under them. The stripes are caused by the ceiling being drier under the joists than at any other place; consequently soot and dust do not adhere as readily. The fitter should be very particular about centering rooms with bay windows. Such rooms, when without center pieces to govern the location of the lights, can be more uniformly lighted from the center of the space if the window is large in proportion to the room. When the room is large in proportion to the window it should be lighted from the center of the square. All irregular shaped rooms with the irregular shaped part of the ceiling divided from the main part by a border must be lighted from the center of the square.

After the rooms are centered, place the long gimlet in the brace (be sure it is well secured, because the brace may slip off and break when left hanging from the ceiling) and bore through the ceiling and floor above. There need be no fear of damaging the carpet, as the gimlet will lift it 6 inches before pushing through, which is enough to mark by. The carpet should be marked at the point over the gimlet to show which side

is most convenient to put the pipe under, as all rooms upstairs do not correspond with those downstairs either in size or location. The gimlet hole in the floor shows which board to take up. When boring plaster or paper center pieces which have candle or oil chandeliers pending from them, select some crevice in the pattern which will leave the gimlet hole in the shadow, then measure to the center and note the direction when cutting the floor above. In paper center pieces, bore near enough to the center to allow the ceiling plate to cover the hole. By following this method the chandelier may hang until the last moment. It also leaves a center for the bit where the chandelier hook is screwed into the joist or into a bridge that cannot be moved. A leather shield should be placed over the gimlet near the brace when boring ceilings, to prevent plaster from getting into the working parts of the brace. It seems needless to mention that when there is no other way of locating a joist that it must be done by "sounding" or by driving a needle through the plaster and finding it by removing the floor above. The fitter will often find chandelier hooks from 6 to 8 inches long, and will succeed easier by plugging the holes left by such, when he is compelled to use them as centers for the bit. We would suggest to the reader who may find occasion to do so, that he place the bridging for chandelier hooks independent of the laths and plaster, and in such a manner that it can be removed without injuring the ceiling. Also, that in no case should a joist be placed directly over the center of a room.

The interior partitions of such houses as this class of work will bring the reader into are usually of wood, which affords many places to conceal gas risers. One of the following places can be found in any house: 1.

Beside a sliding door, which gives more room to lower a light and a better chance to bore through or remove the brace between the studding. The writer almost invariably drives down one end of the most convenient brace. 2. Place the riser as shown in Fig. 22, which is

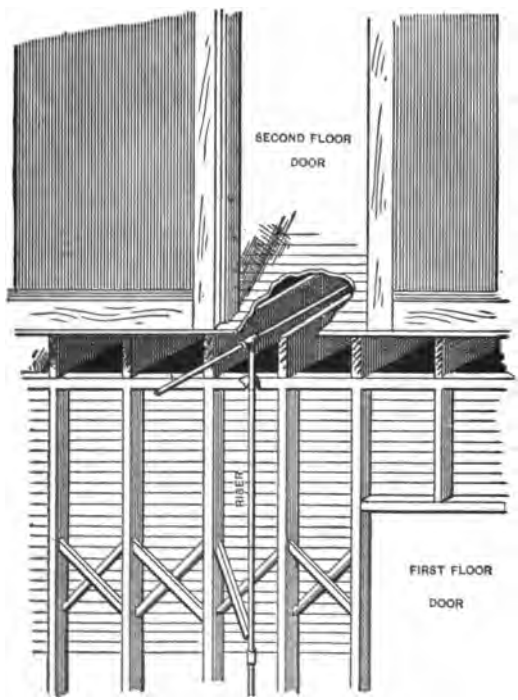

Fig. 22.—Placing Riser in Partition Wall.

so located for either one or both of the following reasons: 1. Because the riser may be placed by lowering through the second floor doorway if there is no cellar immediately under it. 2. Because the stringer over the studding can be cut with much less labor. Any

but the best carpets will look a little loose and shabby after being relaid in the same place, and an inexperienced man will pull the wrinkles out until he comes to an angle, when he finds that the carpet has stretched about two inches. Of course it has to be loosened again. To avoid such mishaps, drive larger tacks in the same holes, fasten the principal points first, and divide the slack or mark the carpet and floor in several places along each edge before taking up. Tacks well driven in heavy carpet can be removed easiest by pulling the carpet. But a tack puller must be used in frail or old carpets, because the carpet will either tear or allow the tack heads to pull through. To remove a floor board neatly the fitter should know on which side of the board the groove is, to avoid splitting too deep, as a board can be forced up from the groove side without damaging any but the part under the groove, and there are no nails on the groove side to contend with. The groove side of a board may be discovered in several ways. The first board laid when putting down new floors is always full width and has the tongue on the outside, while the last board is usually cut to fit, and is sometimes narrow at one end, as the last boards of a floor seldom run perfectly parallel with the wall opposite the starting point. The last board is always nailed through the face instead of being " toed " through the tongue.

Floors that are used without carpet should not be marred by chisel and hammer marks. The writer uses an old putty knife, or something of similar shape, to open the crack between boards wide enough to admit a very narrow thin blade compass saw. In fine floors always saw the tongues on both sides of the board to be emoved. If near an end wall, remove the board to the

base; by this means the crack where the board is sawed can be closed by pulling the board forward. Where a "pocket" (two or three boards) is to be cut, both ends and the tongue on one side of the first board to be removed should be sawed first, then drift the board over, that the tongue may be sawed on the other side to save reducing the face as much as possible. Saw all boards a little beveling to prevent the ends from splintering when they are forced up. All boards covering gas pipes should be screwed down. By referring to

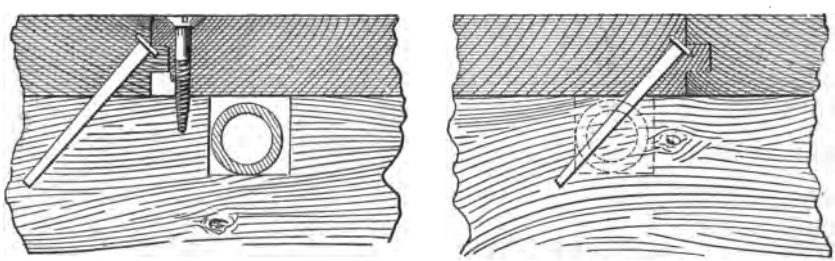

Fig. 23.—Laying Pipes Under Flooring.

Fig. 23 it will be seen that the best place to notch joists is under the groove half of the board, when the boards are from 3½ to 6 inches wide. Under boards from 2 to 3½ inches wide, cut the notches under the tongue side of the board, as shown by the dotted lines in Fig. 23. When fitting houses that have "deadened" floors, place as much pipe parallel with the joists as possible. Once in a while the good appearance of a floor may be saved by drilling the wall from the outside, instead of cutting up two or three boards to get a long piece of pipe under them.

Frozen Gas Pipe.

There is no more aggravating occurrence than to have an evening's business cut short or an evening's entertainment interrupted by the gas freezing out. This trouble is especially prevalent in small towns of cold and changeable climate, and where gas has only recently been introduced. Many reasons might be given for the occurrence of the conditions which cause this state of affairs, but the trouble can usually be traced, not to the intention of the contractors to do their work without care, but to their foremen's errors in employing either inexperienced help or workmen from warm climates, neither of whom are prepared to do work under unfavorable conditions. The average mechanic, whose work is generally satisfactory, constructs his work according to his remembrance of other work which has given satisfaction. The practical mechanic who is capable of first deducing a theoretical result from the existing conditions and then making the result practicable seldom causes after trouble with his work unless he is one of the tramp order.

The writer was some years ago employed to thaw a water pipe in a business block of a Western town. About 5 o'clock p.m., while the weather was fast turning colder, the helper was sent to turn on the stop cock, which was situated in the cellar of a jewelry store. Unfortunately for the helper a gas pipe supplying the jewelry store froze out where it passed under an unprotected grating while he was in the cellar. When the lights went out the jeweler hastily concluded that it was a trick to rob him. Two clerks promptly locked the doors and stood guard over a store full of customers in the darkness, while the proprietor groped his way to the cellar with club in hand. He met the boy on the

steps, and nearly murdered him before discovering that he was not the accomplice of a burglar supposed to be upstairs.

But it is not the result nor the cause of, but the remedy for, frozen gas pipes which we wish to speak of. The first thing to be done when called to thaw a gas pipe is to ascertain whether the gas will burn at all. If not frozen entirely out, light a burner that is fed from the riser and apply the torch to the pipe on the house side of the meter. If this fails, direct the flame against the pipe between the meter and the main. The warm gas flowing through the pipe will thaw the frost in a short time. In cases of emergency, such as being called to a business house late in the afternoon, when there is no time to arrange proper protection for the pipe immediately and there is danger of it being frozen out again before closing time, the fitter may place a spring candlestick under the pipe in such a manner that the candle will be kept pushed up with the flame in contact with the pipe. If only a few of the lights are frozen out it will be found that the pipe supplying them is unduly exposed at some point. That particular point must be found and warmed until the lights burn well. It is hardly necessary to say that in such cases the pipe should be protected or the route changed to a less exposed position at the first opportunity.

All illuminating gas contains more or less moisture. There is not enough moisture in one volume of the pipe to freeze it, but the moisture in one volume freezes at the exposed point. The frost of one volume when once formed is added to until the pipe is completely filled. Possibly local currents, bringing more moisture in contact with the exposed part, accomplish a little of the freezin process, and surely a slow current of gas, pass-

ing through the exposed part to feed leaks in gas pipe where the gas is left turned on to pipes during the day, often accomplishes the entire work of freezing. The freezing of a pipe is often finished by the lighting of a single burner before it is dark enough to require more, or by leaving one burner turned low in the office at night or in the cellar during the day. In cases where the gas is completely frozen out, the fitter should first remove the core of the gas service cock (keep the light at a safe distance), to ascertain which side of the meter

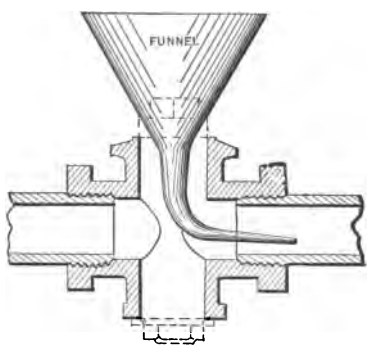

Fig. 24.—Method of Introducing Alcohol.

the trouble is on. If no gas comes, insert the point of a funnel, made as shown in Fig. 24, in such a manner that the alcohol will run through the pipe toward the street main; then pour in half a pint of warm alcohol. If no gas comes in the next few minutes repeat the operation and apply the torch to the pipe, which is sure to bring the gas. In cases of emergency a piece of rubber hose may be slipped over the end of an ordinary funnel, which will answer for that shown in Fig. 24. Notwithstanding the fact that even the best commercial alcohol contains from 7 to 10 per cent. of water, it has

a great affinity for more. The attraction of the alcohol for the water when poured into a frozen gas pipe, and possibly a little aid from friction caused by the intermingling of the alcohol with the fretwork of frost in the pipe, together with the heat in the alcohol raising the mean temperature of the whole, are the best reasons I can give for the alcohol melting the ice.

Where the pipe is found to be frozen on the house side of the meter the fitter should loosen the coupling at

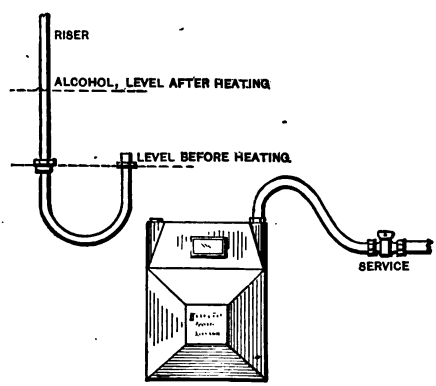

Fig. 25.—Thawing Pipe Near Meter.

the meter and bend the house side lead connection in the shape of a U, as shown by Fig. 25, then fill it with alcohol and close the coupling with a bottle cork. Then with the gas keys open, apply the torch to the bend for five minutes, which will cause the alcohol vapor to ascend the riser and thaw the ice. After heating the alcohol it will be found to have risen several inches above the cork level in the riser. For this reason the fitter should be very careful about emptying the bend. Keep the light at a safe distance when removing the cork.

THE END.

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